

The American Journal of Surgery

Editor: THURSTON SCOTT WELTON, M.D., F.A.C.S.

Editor, Department of Radiology: JAMES T. CASE, M.D., F.A.C.S.

This Issue 176 Text Pages + 107 Illustrations

New Modification for the Injection Method of Arteriography

By Makoto Saito and K. Kamikawa

Submucous Perineoplasty + By W. Wayne Babcock

Lipidol Injection in Biliary Fistulae + By Harold J. Shelley

Carcinoma of the Appendix

By Wm. Edgar Darnall and Robert A. Kilduffe

Electrosurgery + By Grant E. Ward

Effect on the Knee Joint of a Shortened Gastrocnemius Muscle

By John Joseph Nutt

And Twenty-two Other Original Articles

EDITORIAL + Obstetric Mortality + By T. S. Welton

BIOGRAPHICAL BREVITIES + Caspar Wistar + By T. S. Welton

BOOKSHELF BROWSING + The Renaissance and Servetus

By Ben Wolepor

BOOK REVIEWS

SEVENTH INSTALLMENT (to be completed in twelve parts)

POLLOCK and DAVIS' "Peripheral Nerve Injuries"

PORTRAIT OF CASPAR WISTAR

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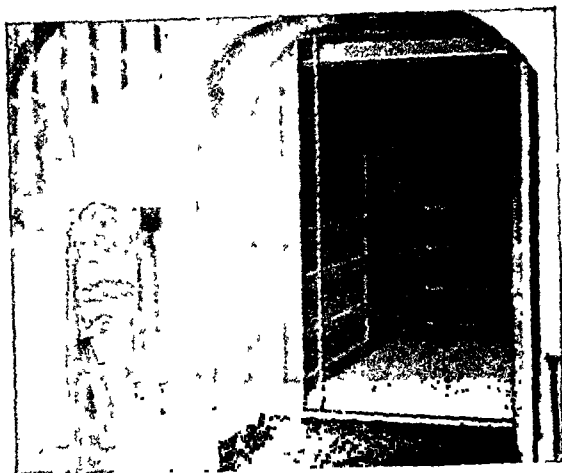
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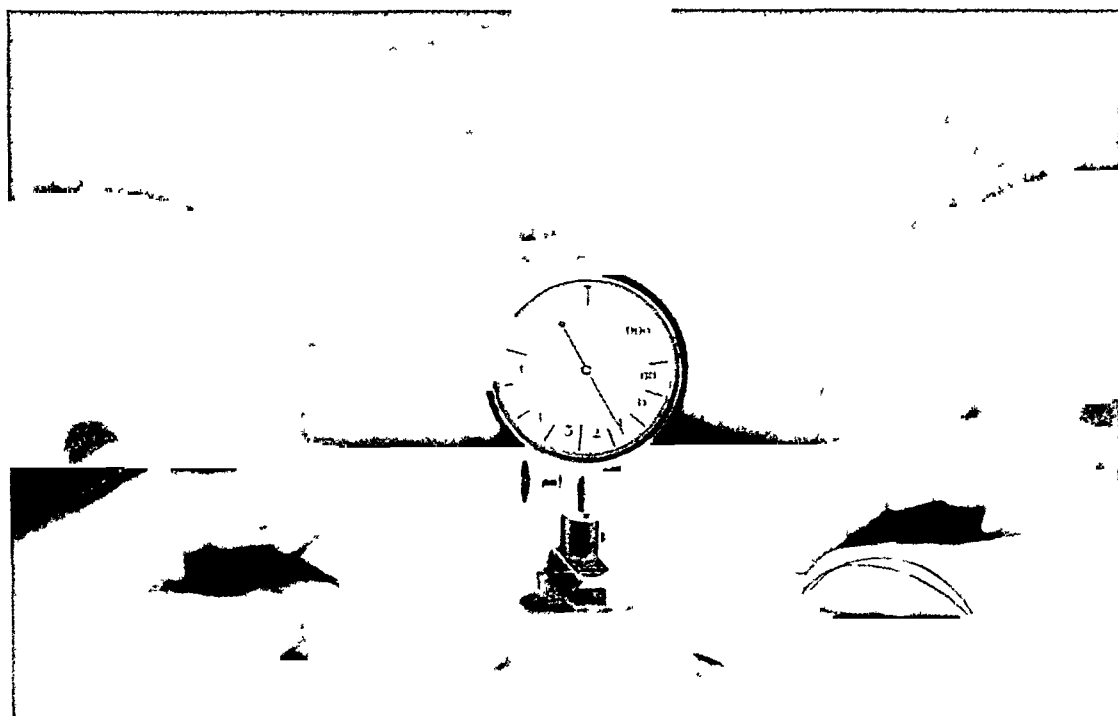
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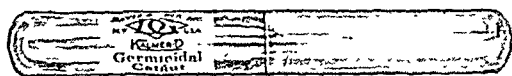
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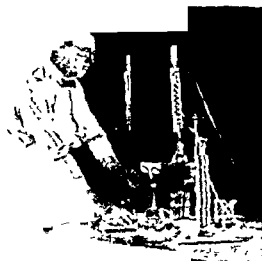


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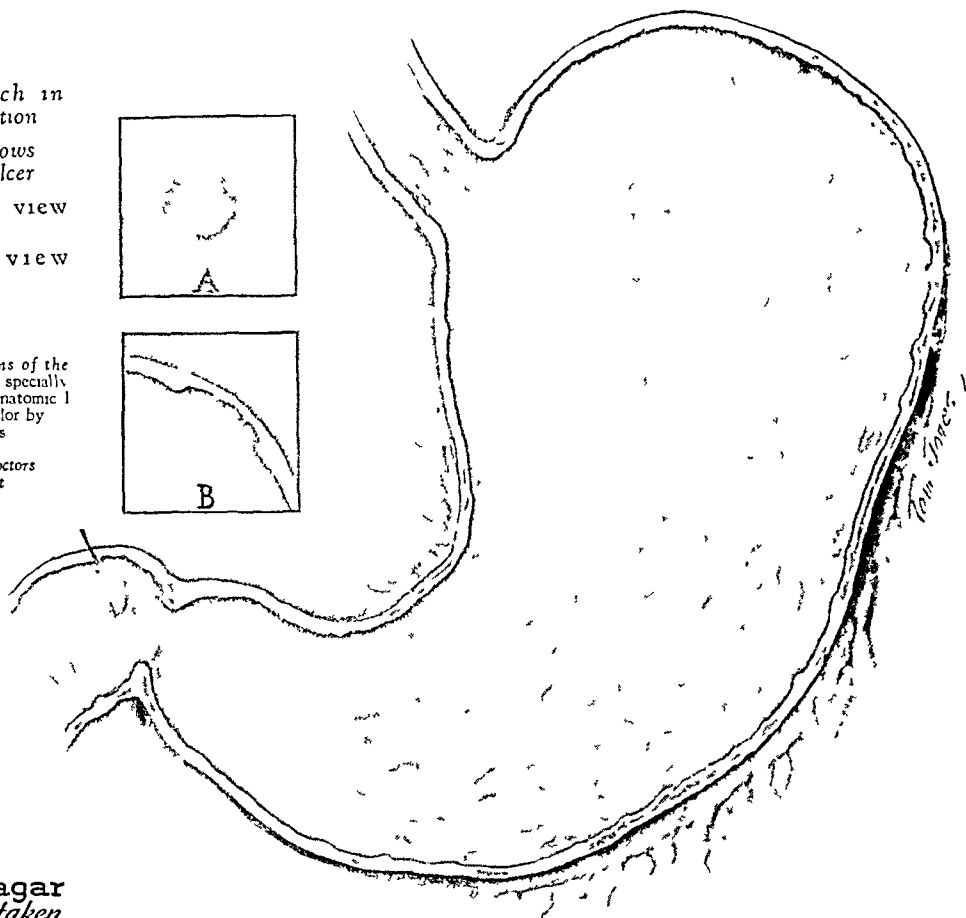
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B—Sectional view of ulcer.

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GENERAL INFORMATION

Original articles are published only with the understanding that they are contributed exclusively to this Journal. Manuscripts offered for publication, correspondence relating to the editorial management and books for review should be sent to The Editor, THE AMERICAN JOURNAL OF SURGERY, 76 Fifth Avenue, New York, N. Y.

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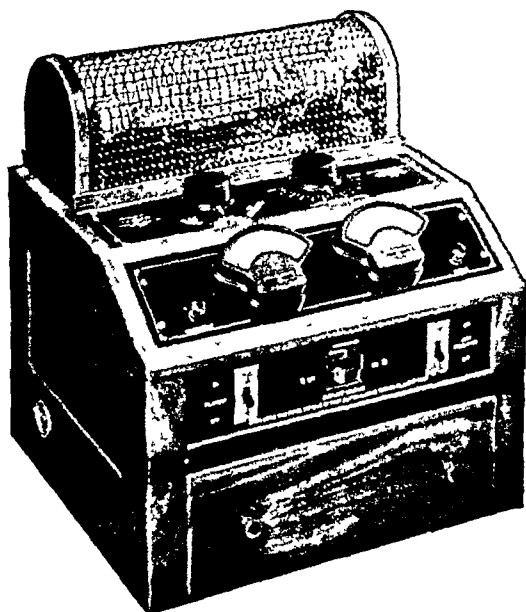
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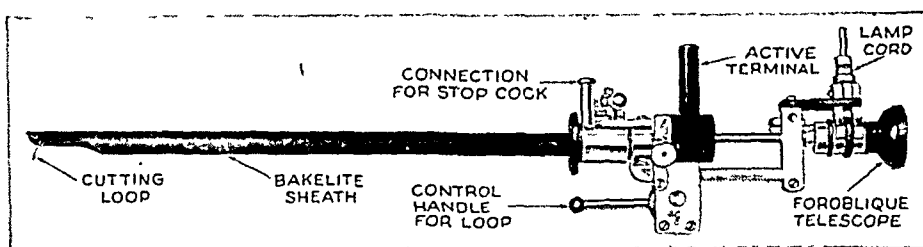
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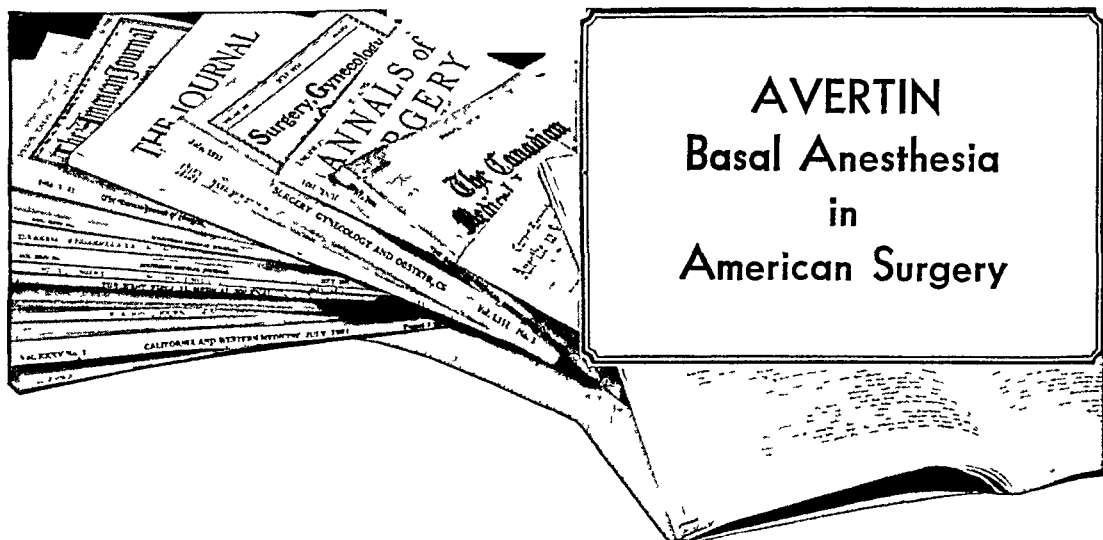
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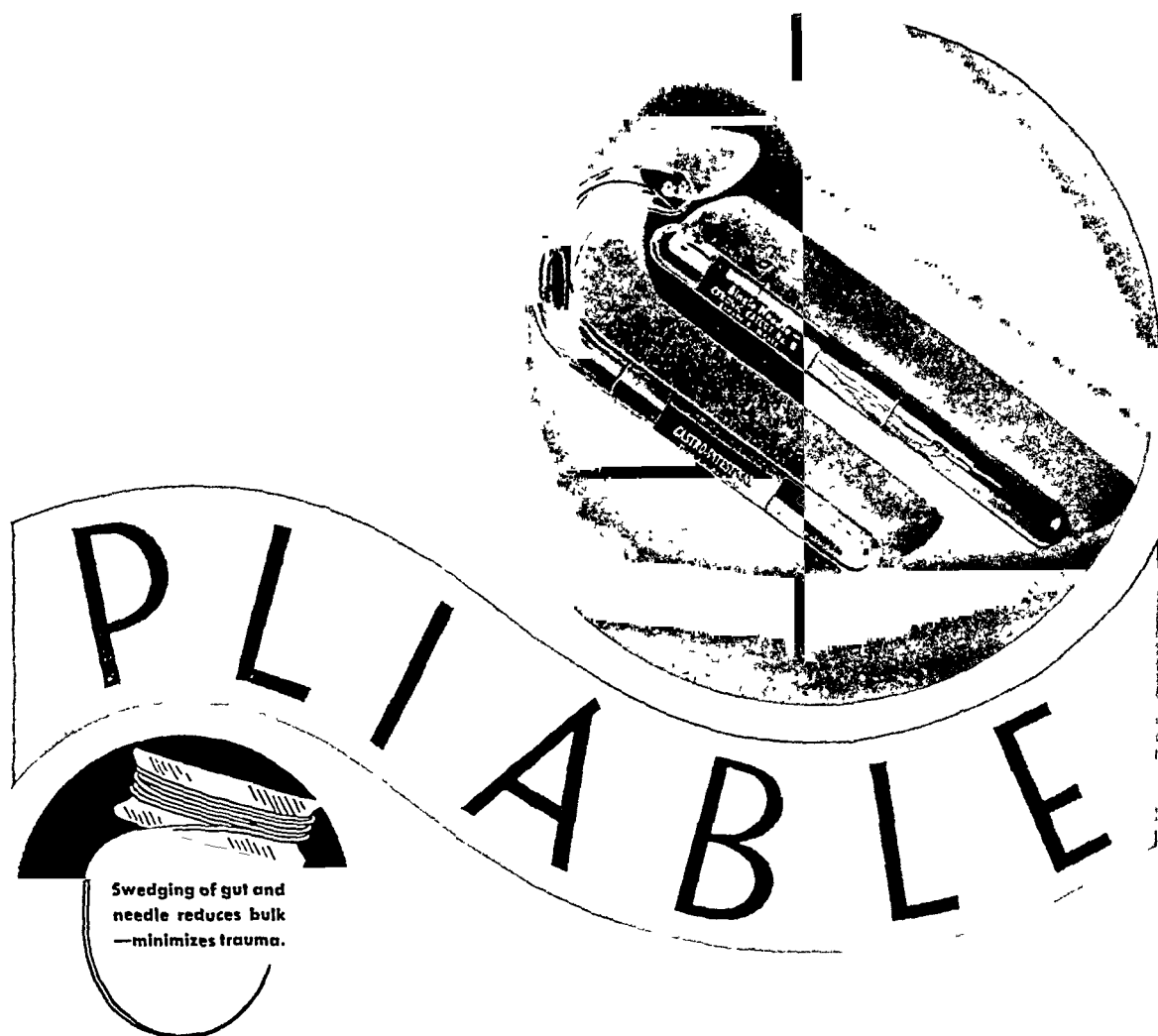
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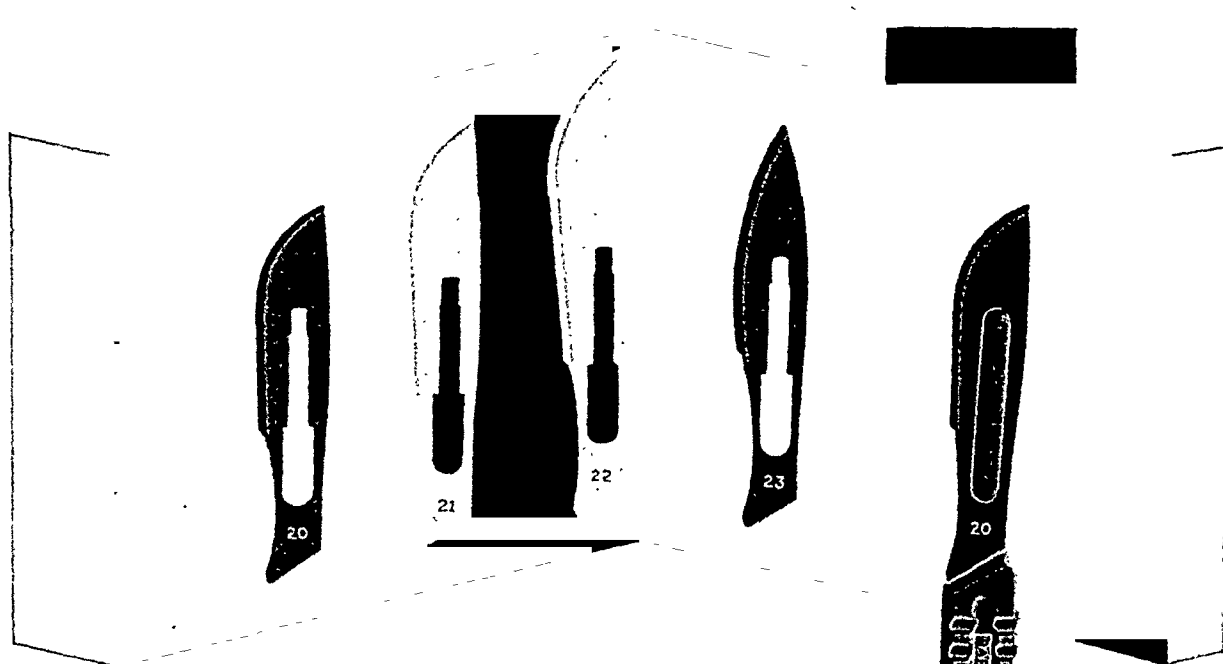
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No. 1

PYOPERICARDITIS

AN ANALYSIS OF CASES TREATED BY PERICARDIOTOMY*

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CHICAGO

VERY comprehensive historical reviews, with summation of our present knowledge of purulent or suppurative pericarditis, have been recorded in recent years by Alexander, Winslow and Shipley, Lockwood, and others. Following the inception of surgical drainage of the pericardial sac with Hilsmann, cases have gradually accumulated in the literature and have been periodically collected.

Alexander, Williamson, and Winslow and Shipley, all working independently, compiled cases reported in the literature for the interim dating from Pool's collection in 1921 until approximately May, 1927, reporting totals of 126, 117, 128 cases respectively. To add to Alexander's collection the 10 personal cases reported by Winslow and Shipley and 1 reported by Williamson, the combined series represents 137 cases. Herewith, an endeavor has been made to advance chronologically this assemblage to the present writing, May, 1931, and to report 2 cases observed and treated by pericardiotomy by the author. During this period of four years 32 cases were reported, establishing a grand total of 171 cases, with 77 early deaths (45 per cent mortality) and 94 recoveries.

This comparatively small group of cases is in no way representative of the incidence of purulent pericarditis. However, its in-

frequent occurrence can be judged by the findings of Barkan and Lucas who, in a review of 3248 autopsies reported at the Harvard Medical School, found only 6 cases. Stone recorded an incidence of 44 (15.5 per cent) in 300 post-mortem examinations performed on patients who died of pneumonia.

Purulent pericarditis, as well as pericarditis in general, was characterized by Osler as the most commonly overlooked serious disease. Abundant corroborative evidence of this statement exists in the literature. Of 68 cases reported by Cabot (1926) 7 only were diagnosed during life and he states that of all cases observed at post-mortem examination at the Massachusetts General Hospital 77 per cent had not received clinical recognition. Reporting from the same hospital, Whittemore found that only 2 patients came to operation over a period of thirty-two years. Poynton, in an investigation of necropsy reports of 100 cases of purulent pericarditis, found that in only 6 cases had the condition been recognized before death. These facts find justification in that in many instances the pericardial involvement enters the clinical picture only as a terminal event, or its presence is obscured by the magnitude of the primary disease process.

With the single exception of direct bacterial inoculation from trauma, such as

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puncture wounds, suppurative pericarditis is always secondary to an adjacent or remote infective focus. Its frequent associa-

The pathological picture presented by purulent pericarditis differs from that of serous cavities elsewhere only in respect to

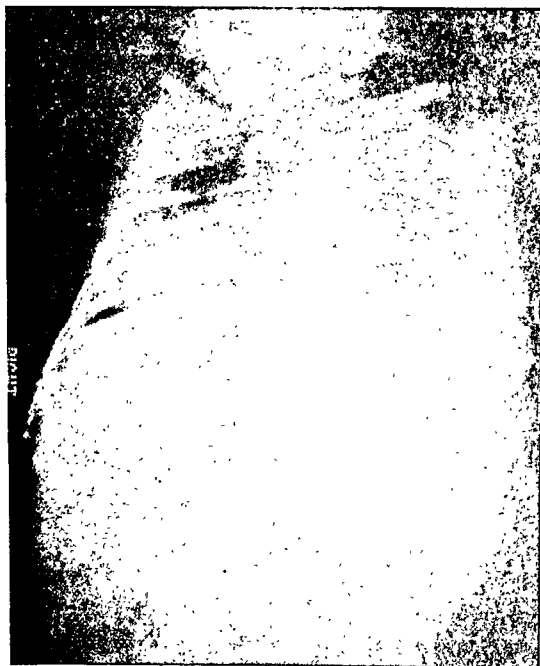


FIG. 1, Case 1. Massive empyema of left pleural cavity displacing heart and mediastinum into right chest.



FIG. 2, Case 1. Same case seven days after institution of closed drainage of left pleural cavity.

tion with pneumonia and empyema suggests an infection by direct extension. Communicating sinuses between the pericardial cavity and the esophagus, and the pericardium and adjacent pyogenic, tuberculous, and actinomycotic abscesses are on record. As a complication in remote suppurative processes such as osteomyelitis a hematogenous interrelationship must be assumed. However, coexisting metastatic abscesses in the heart muscle have been observed and Thomas feels this myocardial involvement is responsible for the high mortality rate concurrent in this group of cases.

Purulent pericarditis as a secondary entity is essentially a disease of the first three decades of life. Of the 171 reported cases, 124 occurred in persons under thirty years of age. The male sex predominated in the ratio of 3 to 1. An etiological analysis of all reported cases has been compiled in Tables I and II.

its relation to the heart. The constant churning action of this organ tends to impede the formation of inflammatory adhesions and often causes fibrin to be deposited on the heart and parietal pericardium in concentric rings and layers comparable to the architectural structure of an onion. The shaggy heart is classical.

Purulent pericarditis, aside from the fairly obvious primary traumatic infections, should always receive consideration in the presence of unexplained symptoms of infection (temperature elevation and leucocytosis) or the continuance or recurrence of these symptoms after a crisis in pneumonia or the establishment of adequate drainage in cases of empyema or osteomyelitis. The physical signs and symptomatology are best classified in respect to the causative pathological physiology. A brief enumeration with percentage frequency as calculated from the entire collected series follows. Many histories

were brief and related in general terms so that at best these figures are merely relative, and only to this extent have value.

tory. It was reported in only 12 per cent of the series, but most cases were not observed at the onset.



FIG. 3, Case 1. Globular enlargement of heart shadow characteristic of pericardial effusion. Drainage tube is in left pleural cavity.

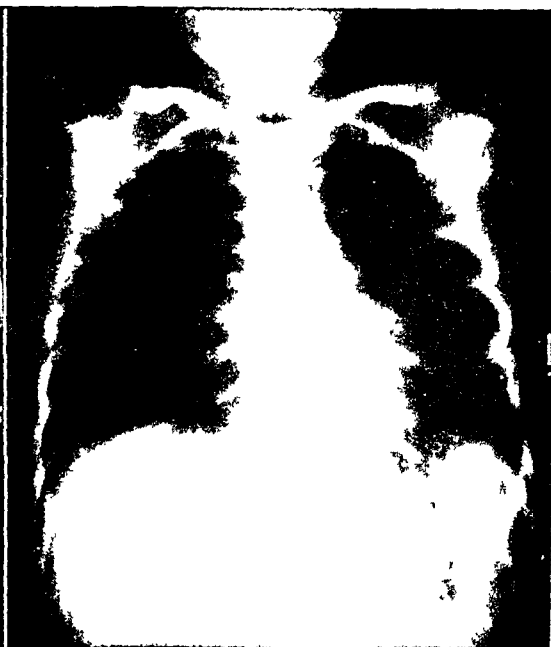


FIG. 4, Case 1. Same case one year after pericardiotomy.

These analyses may be grouped under four headings:

I. Signs and symptoms of the associated primary exciting focus (pneumonia, empyema, osteomyelitis, etc.). Dissociation of symptoms with recognition of the co-existing lesions is frequently difficult.

II. Signs and symptoms in response to infection. These vary with the degree of toxemia produced by the invading micro-organisms and do not differ from those resulting from infection elsewhere in the body. The marked circulatory disturbance, cyanosis, and dyspnea are so strikingly out of proportion to the temperature and other symptoms of toxemia that a lesion of the center of circulatory function should be suspected. Sixty-two per cent of the reported cases had an elevation of temperature, usually not great.

III. Signs and symptoms resulting from the local inflammatory process.

1. A to and fro friction rub is frequently heard at the onset and is invariably transi-

2. Precordial and epigastric pain and distress are apparently not infrequent (15 per cent).

3. Cyanosis (50 per cent).

4. Dyspnea (48 per cent). May be constant or paroxysmal.

5. Tachycardia and arrhythmia (74 per cent).

The three latter symptoms are produced, at least partially, by the abnormal cardiac stimulation and the associated toxic myocarditis. They were strikingly in evidence in the 2 cases observed by the author.

IV. Signs and symptoms resulting from the presence and pressure of the accumulated exudate. As the fluid increases the normal area of cardiac dulness becomes increased in all dimensions. This was recorded in 72 per cent of the cases. It also becomes distorted in respect to the variable distensibility of the pericardial sac which amasses the fluid principally at the base and posteriorly. In consequence there is:

1. A disproportionate broadening of the base.

2. An extension of the dulness to the left beyond the apex beat and to the right

TABLE I

ETIOLOGICAL CLASSIFICATION OF ALL REPORTED CASES

	Recov- eries	Deaths	Total
1. Pneumonia.....	29	18	47
2. Pneumonia and pleurisy, pneumonia and empy- ema.....	8	13	21
3. Empyema.....	4	5	9
4. Septicemia.....	0	3	3
5. Pyemia.....	3	4	7
6. Osteomyelitis.....	8	10	18
7. Puerperal sepsis.....	2	1	3
8. Childhood diseases, scar- latina, measles, etc....	4	3	7
9. Trauma, stab and gun- shot wounds.....	16	1	17
10. Tonsillitis, septic sore throat, (otitis media and mastoiditis).....	5	2	7
11. Pleurisy.....	2	2	4
12. Actinomycosis.....	0	2	2
13. Inflammatory rheuma- tism, arthritis.....	3	0	3
14. Influenza.....	2	3	5
15. Perforation of tubercu- lous cavities.....	0	1	1
16. Esophageal perforation	0	1	1
17. Mediastinitis.....	0	1	1
18. Typhoid fever.....	0	1	1
19. Pulmonary gangrene.	0	1	1
20. Erysipelas.....	1	0	1
21. Not stated.....	7	5	12
	94	77	171

TABLE II
BACTERIOLOGY

	Recov- eries	Deaths	Total
1. Pneumococcus.....	32	13	45
2. Staphylococcus...	10	7	17
3. Streptococcus...	12	11	23
4. Influenza bacillus ..	0	1	1
5. Colon bacillus ..	1	0	1
6. Mixed pyogens	2	2	4
7. Unclassified..	2	3	5
8. No growth	5	1	6
9. Not stated	30	39	69
	94	77	171

of the right sternal margin with obliquation of the cardiohepatic angle (Rotch's sign).

3. Absent or muffled heart sounds and apex impulse (58 per cent).

4. Limitation of movement of the left chest and a positive Hoover's sign.

5. Signs of lung compression posteriorly (Bamberger's sign) (20 per cent).

6. Precordial bulging with widening of the interspaces in children (8 per cent).

7. A characteristic posture of sitting upright and leaning forward (21 per cent).

8. A somewhat distinctive cyanosis associated with pallor. (Dyspnea, arrhythmia, tachycardia, and precordial pain have mechanical as well as reflex sources so bear repetition under this heading. Williamson, Blake, Rhodes, and Parker all relate experiences in which irrigating solution introduced after the establishment of drainage had not returned but had accumulated within the pericardium and resulted in increased interpericardial pressure with the onset of the symptoms of cardiac embarrassment described above. Kuno and Hietler by experimental irritation and electrical stimulation produced similar phenomena.)

A group of less constant pressure symptoms were reported too infrequently to be given percentage recognition:

1. A dry reflex cough.

2. Dysphagia.

3. Hiccough.

4. Vomiting.

5. Aphonia.

6. Engorgement and visible pulsation of the jugular veins and dilation of the superficial veins of the thorax.

7. Enlargement of the liver.

8. Ewart's first rib sign.

9. Horner's syndrome.

10. Precordial tenderness and edema.

With progression of the pericarditis frank heart failure ensues, with exaggeration of the cyanosis and dyspnea, and the development of general passive congestion and edema.

The roentgenograms as reported in 25 per cent of the cases registered rather characteristically enlarged heart shadows. Holmes summarized his observations:

1. An abnormally shaped and enlarged heart shadow which changes with alteration of the position of the patient, a sign not present in any other condition.

2. Obliteration of the normal heart outlines.

3. Change in the shape of the angle formed by the posterior border of the heart, the diaphragm, and the spine.

4. Faint or absent pulsation with fluoroscopic visualization. With the induction of pneumopericardium, Harloe was able to demonstrate a fluid level shadow and a thickened pericardium.

The electrocardiograph and other instruments of precision offer no assistance in the verification of the diagnosis of pericarditis.

The mortality rate in purulent pericarditis without operation closely approximates 100 per cent. Dujol and Aritzenius however have reported cases of patients who completely recovered after one drainage by pericardiocentesis. With adequate surgical drainage, as indicated by an analysis of all reported cases, this rate has been reduced to 45 per cent. There appears to be very little evidence forthcoming of permanent residual cardiac damage. In only 3 cases was symptomatic evidence of an adhesive pericarditis reported.

The differential diagnosis invites a consideration of such conditions as hemorrhagic or simple serous pericardial effusions, cardiac hypertrophy or dilatation, empyema (encapsulated), mediastinal neoplasms, mediastinitis, subdiaphragmatic abscess, coronary accidents, and penetrating ulcer. Le Conte and Roberts feel that as an assistance in the establishment of the diagnosis pericardiocentesis, carefully and skilfully performed, is a very simple and essentially harmless procedure, despite opinions to the contrary by Coutts, Balance, and Rhodes. Matas mentions nine deaths resulting from puncture of the heart in the performance of pericardiocentesis. The pericardium is probably most safely approached with an aspirating needle through the left costal xiphoid angle. In-

fection of the pleural cavity is rarely caused by this procedure, but not infrequently follows pericardiotomy.

There is a unanimous agreement that pericardiocentesis as well as expectancy commands no place in the treatment of suppurative effusions. The early establishment of free and dependent drainage is indicated. In its accomplishment six methods of approach have been used.

1. Simple intercostal incision. The inadequacy of drainage has resulted in its general abandonment except as a means of inserting a catheter for drainage and irrigation. This has been accomplished through a trocar as in closed intercostal thoracotomy for empyema.

2. Resection of one or two of the left costal cartilages ranging from the fourth to the eighth inclusive. The internal mammary vessels are divided or retracted medially and the pleural reflection pushed laterally if necessary. This probably is the procedure of choice for most cases.

3. Resection of corresponding costal cartilages on the right side of the sternum. Shipley and others on occasion have found it expedient to use this approach, but its employment should rarely be necessary.

4. Trans-sternal. The pericardium is readily exposed through a trephine opening in the lower portion of the sternum. The limited opportunity for exploration of the pericardial cavity presents a great disadvantage.

5. Xiphocostal (Larrey) and epigastric routes provide most dependent drainage, and on this basis have many advocates. In the latter, the peritoneum is reflected downward and the pericardium exposed through the diaphragm at the junction of its sternal and costal attachments.

6. Posterior approach. This has been used to gain access to a collection of pus in the posterior pericardial recess by either traversing compressed lung tissue or an empyema cavity. Louchs has reported 2 cases of patients successfully drained by this approach.

Once adequate drainage has been established its maintenance must be assured until the pericardial sac has become rela-

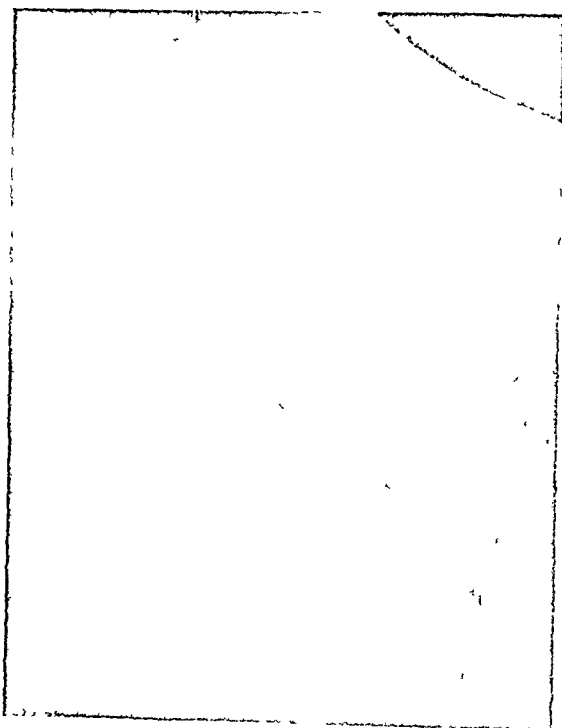


FIG. 5. Case 1. One year after operation. Pericardiotomy scar shows slight retraction synchronous with systole.

tively sterile. Considerable variance in the methods used to gain this end and controversial opinions appear in the literature. Shipley, who enjoys a wider experience with pericardiotomy (11 cases) than any other surgeon, advocates open drainage through a trans-sternal approach in children and a xiphocostal approach in adults with the insertion of Dakin's tubes into the most dependent portion of the pericardial sac. He stresses the necessity of exploring the entire confines of the pericardium with the finger to open up any possible walled-off abscess. Air-tight closed drainage with frequent irrigation of saline or Dakin's solutions through an inlying catheter has been used by Harloe and Bowers. Negative pressure drainage has been employed by Whittemore. Various forms of rubber tub-

ing and gauze packs have been utilized. Equally effective drainage has been accomplished without the insertion of any foreign body but merely by suturing the pericardium to the skin or subcutaneous tissue. Peterson secures dependent drainage by means of posture, that is, turning the patient on his face periodically.

The observations made by Beck and Cox suggest that definite physiological advantages are to be gained by the air-tight method of drainage. Experimentally, they demonstrated that cardiac efficiency was considerably reduced by tamponage when exposed to atmospheric pressure. Metivet, Harrigan and Ljunggren report cases in which the heart ceased beating simultaneously with the opening of the pericardium, the "stand-still" heart. Return of function was attributed to massage, mechanical stimulation, and in 1 case, the injection of ephedrine.

CASE HISTORIES (AUTHOR'S CASES)

CASE 1. Recovery. M. S., an emaciated white female child, aged six years, was seen in consultation and referred to the hospital February 25, 1930, with a diagnosis of post-pneumonic empyema of the left pleural cavity. The preceding history can be summarized as essentially unimportant until the onset of an upper respiratory infection four weeks previously. This was followed by a left lower lobar pneumonia terminating in two weeks with a pseudo-crisis and then by lysis.

A week before admission, the temperature elevation and other symptoms of a toxemia recurred. Signs of a pleural effusion developed rapidly in the left side of the chest. Pleurocentesis was done with aspiration of thick creamy pus containing pneumococcus in smear and culture (not typed). The roentgenograms (Fig. 1) indicated a massive effusion of the left pleural cavity with displacement of the mediastinal structures into the right side of the chest.

Upon the patient's admission the temperature was found to be 103.2°F. (R), respirations 52, the pulse 148, leucocytosis of 28,000 and the

red blood cells numbered 4,000,200. The urine was negative. A closed intercostal drainage of the left pleural cavity was immediately instituted. This was followed by a prompt amelioration of symptoms and an afebrile course from the third to the tenth postoperative days. Figure 2 represents the x-ray findings seven days after operation. On March 7, ten days postoperatively, there was a rather sudden onset of cyanosis, dyspnea, restlessness, tachycardia, a desire to sit up and a mounting temperature of 102.6°F. (R). There was a marked irregularity of the rhythm and volume of the pulse and a definite to and fro friction rub. The heart sounds were distinct. On the following day, the patient's condition was greatly improved. The friction rub had disappeared and the circulatory disturbance was much less pronounced. During the next two days, the temperature began to picket from 99.6° to 103.8° (R), a dry hacking cough developed, dyspnea increased, and the patient chose a sitting posture with the head resting forward on a pillow. By the third day there was a marked pallor with the cyanosis (a livid hue), restlessness, and an anxious facial expression. The pulse (160 plus) was of poor volume and markedly irregular, the heart sounds were barely audible, and the apex impulse could not be obtained. The left chest bulged somewhat and did not move as freely as the right. The superficial veins were dilated. The area of cardiac dullness as outlined by percussion extended in a straight line 3 cm. to the right of the right sternal margin from the liver dullness below to the first interspace above, and to the left 3 cm. in the second interspace and the anterior axillary line at the apex. The base measured approximately 8 cm. at the second interspace. There were dullness and diminished breath sounds and tactile fremitus over the entire left chest posteriorly. The roentgenogram taken at this time and shown in Figure 3 was characteristic of a pericardial effusion. Fluoroscopic visualization showed absence of pulsation of this greatly enlarged globular heart shadow. The urine was negative, the white blood cells numbered 32,000, the blood culture was reported "no growth," and the blood pressure was 82/56 mm.

March 11, 1930, a pericardiocentesis (needle introduced at the xiphocostal angle and directed inward and upward) yielded approximately 400 c.c. of seropurulent fluid (bacterio-

logically pneumococcus). There was an immediate marked improvement in the patient's condition. Two hours later with local anesthesia the fourth and fifth left costal cartilages were exposed through a curvilinear incision and both cartilages removed. The pericardium immediately presented into the wound. The internal mammary vessels were retracted and the pericardium incised. Considerable seropurulent fluid, containing a few flecks of fibrin, welled up into the wound with the churning action of the heart and was removed by suction. The gloved finger was then introduced and circumscribed the outlines of the pericardial sac. No adhesions were felt. The incised edges of the pericardium were then sutured to the subcutaneous tissue, the wound left wide open, and dressings applied. The patient was placed in bed with her face down and kept in this position and on the left side as much of the time as was compatible with her comfort.

After the first forty-eight hours, the patient made a satisfactory and rapid convalescence. The pericardiotomy wound healed by granulation and was entirely closed in three weeks. Figures 4 and 5 show the condition of the chest and the scar one year after operation. The patient enjoys normal health and activity with no cardiac embarrassment, and presents no physical signs of residual cardiac damage.

CASE II. Death. R. C., Jan. 3, 1928. A white male of twenty years with unimportant past and family histories suddenly developed chills, a temperature of 104°F., a severe headache, and pain and tenderness in all the muscles of his body. His throat was sore and his neck was stiff.

Examination on the following day revealed a red, angry, edematous throat with extensive membrane on the pharynx and both faucial tonsils and large tender cervical lymph nodes. A smear from the throat was negative for diphtheria bacilli. January 6, the third day after onset, he was taken with a rather sharp pain in the epigastrium and an inability to breathe lying down. The throat appeared to be less edematous and some membrane had been desquamated. The temperature was picketing from 101.5° to 105°F. There were several cutaneous petechial hemorrhages, considerable dyspnea, a definite cyanosis, and a marked arrhythmia with clear rapid heart sounds, but no rub or demonstrable enlarge-

ment of the heart. A blood culture taken at this time was reported later as a pure growth *Streptococcus hemolyticus*. The urine contained a trace of albumin and the white blood cell count was 12,000.

January 8, the dyspnea, cyanosis and arrhythmia had increased and the patient, sitting upright and laboring for breath, was obviously very critically ill. The area of cardiac dullness was considerably enlarged in all dimensions, notably at the base and to the right of the sternum. There was a positive Bamberger's sign and an absence of both the apex beat and heart sounds. The liver edge could be palpated 2 cm. below the costal margin. The pulse was rapid, irregular, and thready and could not be counted. Due to the constant refusal to have the patient removed to the hospital, x-ray examination was impossible. A pericardiocentesis was done in the sixth interspace, and 600 c.c. of blood-tinged fluid slowly removed. The patient experienced immediate and marked relief. The fluid cultured hemolytic streptococci. Four hours later the patient's general condition had improved sufficiently, it was felt, to withstand operative drainage. Consequently a pericardiotomy by the xiphocostal approach was done under local anesthesia and the wound was left wide open with a small catheter placed in the bottom of the posterior recess of the pericardial sac. Upon incising the pericardium there was a gush of considerable blood-tinged fluid and the surfaces of the pericardium and heart were markedly engorged and presented numerous minute petechial hemorrhages.

The pericardial cavity was irrigated every three hours with warm salt solution and for the next twenty hours the patient appeared to be progressing satisfactorily when he became delirious, developed opisthotonos and mild convulsive seizures. He died January 10, 1928, thirty-six hours after operation. Autopsy was refused.

CASE HISTORIES COLLECTED FROM THE LITERATURE FROM MAY, 1927 TO MAY, 1931

CASE 1.* Recovery. A female child aged four years and ten months was admitted to St. Bartholomew's Hospital October 7, 1928, with acute osteomyelitis of the left femur

* Beattie, W. J. H. M. *St. Bartholomew's Hospital J.*; Thomas, T. M. *Arch. Dis. Childhood*, 4: 67-75, 1929.

which was immediately drained. Four days later bronchopneumonia developed in both lungs and after eight days subsided by lysis, but a slight cyanosis, elevation of temperature and high pulse and respiratory rates persisted. The leucocyte count was 23,800.

November 1: The area of cardiac dullness extended 1 in. outside the midclavicular line on the left and $\frac{1}{3}$ in. to the right of the right sternal border. The apex beat was not palpable and the heart sounds were not audible. The x-ray examination showed a heart shadow enormously enlarged in all directions, especially upwards, with the typical rounded appearance associated with pericardial effusion. On the following day, through an epigastric approach, the pericardial cavity was opened with the escape of 12 to 14 oz. of fluid. The wound was closed tightly but, upon receiving the bacteriological report on the following day, was reopened and a tube inserted through which irrigations were carried out.

A week later a left thoracotomy was done. The convalescence was further complicated by ascites and edema of the extremities but terminated in complete recovery.

CASE 11.* Recovery. A Chinese soldier, aged nineteen, with a rifle bullet retained in the chest, presented four days after injury, blood-tinged sputum, increasing dyspnea and cyanosis, a temperature of 39.6°C., respirations, 36, and a pulse rate, 120. The heart was pushed markedly to the right and had a regular rhythm and no murmurs. The base of the left side of the chest was flat and the right dull with coarse râles throughout the entire chest and fine râles at the right base. The voice sounds were suppressed and tactile fremitus was absent at the left base and the percussion note hyper-resonant at the left apex. Chest plates localized the bullet at the level of the tenth rib in the midaxillary line. Upon a diagnosis of hemothorax or pyohemothorax, two unsuccessful attempts at thoracentesis were made.

Then 100 c.c. of yellow turbid fluid were removed by pericardiocentesis. Two days later this procedure was repeated and both the smear and culture of the fluid demonstrated hemolytic streptococci.

On the following day a pericardiotomy was done through an exposure gained by resecting the cartilage of the sixth rib. No drainage tubes were inserted but the pericardial sac was

* Loucks, H. H. *Arch. Surg.*, 18: 852-867, 1929.

frequently irrigated with a solution of chlorinated soda.

It became increasingly evident that drainage was inadequate and that there was a walled-off abscess in the posterior pericardial cul-de-sac, so thirteen days after the anterior drainage a posterior pericardiotomy was done through an empyema drainage sinus previously established in the posterior axillary line with resection of a section of the eighth rib. This was done with the evacuation of 800 c.c. of pus. The patient was immediately relieved and made a slow but constantly progressive convalescence and one year later was able to do ordinary labor.

CASE III. Death, *idem*. A man, aged thirty, with a diagnosis of pulmonary tuberculosis gave a history of abscesses of the neck and right inguinal region three and two months respectively before the onset of symptoms of a pericarditis. The patient complained of pain over the precordium and progressive weakness and dyspnea.

Examination revealed bulging of the precordium from the second to the sixth interspace. The area of cardiac dullness extended from 3 cm. beyond the left midclavicular line to 4 cm. beyond the right midclavicular line. The temperature was 102°F., the pulse was rapid but the heart sounds could be clearly heard. The x-ray examination showed the heart shadow to be markedly increased in all diameters with displacement of the mediastinum to the right. No tubercle bacilli were found in the sputum and the white blood cells counted 18,000.

A pericardiocentesis was done with the escape of 20 c.c. of pus. This contained no tubercle bacilli but cultured *Staphylococcus aureus*.

The costal cartilage of the fifth rib was resected and the pericardium exposed and incised. It was so densely adherent to the heart muscle that an attempt to establish drainage at this site was abandoned and the pericardial sac drained in the posterior axillary line by perforating the lung which was adherent to both the pericardium and chest wall.

The symptoms referable to the pericarditis promptly subsided but the inguinal sinus continued to drain and there developed a destructive lesion with wedging of the first and second lumbar vertebrae with a perispinal abscess pointing posteriorly. This was incised and a diagnosis of actinomycosis established. The patient died soon afterward.

CASE IV.* Recovery. A white male of twenty-seven years was seen April 24, six weeks after the onset of pneumonia, and presented evidence of fluid in the pericardial and both pleural cavities. There was marked dyspnea, cyanosis, a rapid feeble pulse, a septic temperature, painful respiration, muffled heart sounds, and a history of a pericardial rub. X-ray observation showed enlargement of the heart to both sides, fluid in the left chest and encysted fluid in the right pleural cavity. The leucocyte count numbered 11,000.

On April 25 the right empyema cavity was drained and pneumococcus, Type 1, was cultured from the pus. On April 26 the left pleural cavity was aspirated of 500 c.c. of clear fluid. On April 28 pericardiotomy, with resection of the sixth costal cartilage and insertion of a drainage tube, was followed by irrigations with saline and Dakin's solutions. Type 1 pneumococcus was found in the pus from the pericardial cavity.

The patient had a stormy but satisfactory convalescence and subsequent examination showed no evidence of residual cardiac damage.

CASE V.† Death. A white male child of one year was admitted to the hospital November 14 with a history of good health until the onset of pneumonia four weeks previously. On admission the temperature was 99.2°F., the pulse 140, respirations 52, and the child was very dyspneic and acutely ill. There was evidence of consolidation of the lower lobe of the left lung and râles were heard over both lungs. The liver was palpable 2 cm. below the costal arch. The x-ray studies of the heart showed the characteristically enlarged shadow of a pericardial effusion.

November 23, 25 c.c. of pus were aspirated from the pericardial cavity and from it the influenza bacillus was identified. Two days later the fifth costal cartilage was resected and drainage established. A rubber tissue drain was inserted and irrigation with saline instituted. On the following day the lung signs increased and the patient died thirty-six hours after operation.

CASE VI. Recovery. *Idem*. A white female child of 3½ years entered the hospital June 14 with a history of a blow on the head followed by temperature for two weeks varying from

* Harrington, S. W. *Surg. Clin. North America*, 9: 133-138, 1929.

† Peterson, E. W. *Arch. Surg.*, 16: 366-379, 1928.

100°F. to 104°F. The pulse was 144, respirations 60, the heart sounds distant; and a greatly enlarged heart shadow was demonstrated by percussion and x-ray examination. Five days later the pericardial cavity was aspirated and the pus removed contained *Staphylococcus albus*. June 25, the sixth costal cartilage was resected and the pericardium opened with the escape of 750 c.c. of thick pus. The pericardium was sutured to the chest wall and no drainage material inserted but the patient was turned on her face for thirty minutes every three hours to accomplish gravity drainage. The convalescence was rapid and uneventful and there was no evidence of residual functional cardiac damage.

CASE VII. Recovery. *Idem*, Feb., 1928. A white male child aged fourteen years was critically ill with lobar pneumonia of the left lower lobe for two weeks. By March 10, signs and x-ray evidence of an effusion of the left chest and of a large pericardial exudate were definite. The temperature was 105.6°F., respirations 40, pulse 140 and dyspnea was marked. Repeated thoracenteses and later a thoracotomy were done to drain the left pleural cavity.

On March 23 the pericardium was aspirated of 1600 c.c. of pus (*pneumococcus* Type II). Two days later the sixth and seventh left costal cartilages were removed and the pericardial cavity opened. The pericardium was sutured to the intercostal fascia and no irrigation or drainage material was used. As in the preceding case, postural drainage was employed. During convalescence there was some edema of the legs and myocardial insufficiency was feared, but this disappeared after the evacuation of reaccumulated pus in the previously drained pleural cavity. Further convalescence was then rapid and uneventful.

CASE VIII.* Recovery. (Reported by Williamson but not by Alexander.) A case of purulent pericarditis following empyema, cured by closed catheter drainage accomplished by intermittent suction and no irrigation. *Pneumococcus* was the infecting microorganism.

CASES IX and X. Deaths. *Idem*. Two cases of *Streptococcus* septicemia involving the pericardium. Both were treated by suction through a closed drainage catheter as in Case VIII.

CASE XI. Death. *Idem*. A case with undetermined bacteriology was treated by the removal of a costal cartilage, the insertion of two tubes and irrigations. The patient died of septicemia.

CASE XII.* Death. Suppurative pericarditis developed as a complication of scarlet fever and drainage was established by the resection of the left fourth and fifth costal cartilages. Tissue drains were led into the pericardial cavity and the same was irrigated. Death was caused by a continuous uncontrollable hemorrhage.

CASE XIII. Death. *Idem*. This case received the same treatment described in Case XII. At autopsy an apical tuberculous cavity was found to communicate with the pericardial sac through a sinus.

CASE XIV.† Death. A boy of eighteen was stabbed over the sternum with a knife. There was marked shortness of breath and x-ray examination revealed 1½ in. of the knife blade imbedded in the sternum. In the course of its removal a suppurative process of the pericardial sac was discovered. Drainage was established but the patient died from recurring hemorrhages despite repeated transfusions.

CASES XV and XVI.‡ Recoveries. No discussion was given of these cases.

CASE XVII. Death. *Idem*. A child with empyema developed a purulent pericarditis, was operated upon and died.

CASE XVIII. Death. *Idem*. A case with the pericardium secondarily infected with actinomycosis by a needle.

CASE XIX.§ Recovery. The patient was a boy, four years old. The onset of the disease was gradual, with chilliness for three or four days and little languor and fever at times. One night he complained of pain in the throat, and immediately began to have difficulty in breathing. Notwithstanding the negative findings of the throat, he was given an injection of diphtheria antitoxin. He became progressively worse and complained of a choking sensation.

On examination there was a marked pleural effusion on the left side. The pulse was 160,

* Miller, R. T. *Arch. Surg.* (discussion), 16: 366-379, 1928.

† Andrus, D. W. *Arch. Surg.* (discussion), 16: 366-379, 1928.

‡ Lilienthal, H. *Arch. Surg.* (discussion), 16: 366-379, 1928.

§ Zeno, A. *Bol. y. Trab. de la Soc. de Cir. de Buenos Aires*, 11: 452-456, 1927.

* Whittemore, W. *Arch. Surg.* (discussion), 16: 366-379, 1928.

small but regular. There was no precordial pulsation, the apex beat could not be localized, and the precordium was bulging. The cardiac dulness was enlarged, extending down to Traube's space on the left, far beyond the normal limit on the right and down to the liver dulness. The heart sounds were very faint. The temperature was 102.2°F. Puncture of the right pleural cavity yielded creamy pus, which was sterile on direct examination and on culture. Three days later, 150 c.c. of pus were evacuated from the same side by aspiration.

Two days later, under local anesthesia, a portion of the sixth cartilage was resected, the internal mammary artery ligated, and the pericardial sac was opened. A large amount of liquid pus escaped and a drainage tube was placed in the cavity. The pleura was punctured and emptied from time to time and the patient recovered in a month.

When he returned to the clinic four years later, the cardiac measurements were normal, and the x-rays showed normal heart action. "No traces of this grave disease remained."

CASE XX.* Recovery. The patient was a woman twenty-three years old. She entered the hospital on December 10, 1926, with a thrombophlebitis of the left jugular vein following an attack of influenzal otitis which had been present for fifteen days. Her temperature was 104°F.

A left mastoidectomy with resection of the thrombosed portion of the jugular vein was done. A blood culture was made on the same day and was negative. The immediate post-operative result was excellent.

Her temperature rose again on the fourth day and she complained of abdominal pains. It was thought at first that she had appendicitis or salpingitis. However, she soon had dyspnea with signs of a pleural effusion at the right base. An exploratory puncture was negative.

On account of continuous dyspnea she was obliged to remain seated in her bed. The area of cardiac dulness was increased and the heart sounds were weak and distant. A radioscopic examination showed that the cardiac shadow was enlarged and that there were no pulsations of the pericardium.

* Ramond, L. *Presse Méd.*, 36: 763-64, 1928; Ramond, L., and Weill-Spire, R. *Bull. et mem. Soc. med. d'hop. de Par.*, 51: 1163-1166, 1927.

A puncture by the epigastric route was done on December 29 and 240 c.c. of greenish pus were obtained. This pus contained pneumococci. She was relieved by this procedure and improved for forty-nine hours.

On the morning of December 31, she attempted to lie down and was suddenly seized with cyanosis and dyspnea and a weak and rapid pulse. There were pulsations of the jugular veins. A parasternal puncture only permitted about 30 gm. of pus to be removed and the symptoms remained unchanged. Two subsequent aspirations were done with only temporary relief. Her face was livid, her pulse was thready, her body was covered with cold perspiration and syncope was imminent, on January 8.

With the patient in a semi-reclining position, a vertical incision was made at the level of the tip of the xiphoid appendix under local anesthesia. The appendix was resected, the pericardium was opened, and from 300 to 400 c.c. of pus escaped. A strip of folded rubber sheeting was introduced into the pericardial cavity for drainage.

The pain and dyspnea were relieved but her condition still remained critical during the following days. However, she made a complete recovery and left the hospital on April 29.

She was again seen in June and was in excellent condition. A clinical and radiological examination of the lungs and heart did not show any trace of the pericardial inflammation.

CASE XXI.* Recovery. The patient was injured in the early part of January by a bullet from a revolver, entering the chest at the left sternal margin. She was brought to the hospital in a pulseless condition and in shock. The patient recuperated after several days, but distinct signs of an acute pericarditis manifested themselves. After the patient had recuperated, roentgenological examination was made. The bullet was situated directly above the outline of the stomach upon the diaphragm, the shadow of the heart was enlarged to the left and showed the pouch-shaped wine-bottle form characteristic of pericarditis. The temperature at that time was subfebrile. The roentgenologist concluded from the findings that the projectile was situated within the pericardium. On January 31, the thorax was opened by means of a costoxiphoidal incision (according to Rehn) and the pericardium was

* Albrecht, P. *Wien. med. Wchnschr.*, 77: 390, 1927.

incised. It was covered with a thick yellowish-red layer of fibrin. Upon opening this membrane, about 250-300 c.c. of a turbid serous-hemorrhagic fluid escaped. The projectile at the outer side of the left ventricle was removed with a pair of forceps. The wound was drained and the drainage was shut off towards the outside by means of a sterile rubber glove, in order to prevent the entrance of air. The patient is now permanently free from symptoms.

CASE XXII. Recovery. *Idem.* The patient had been injured by a pistol shot in the right thoracic cavity in October, 1919. The projectile was situated in the mediastinum close to the median line in the pericardial-hepatic angle. It was not removed. The existing hemothorax caused no anxiety. The temperature soon was normal, so that the patient was discharged after three weeks, pursuant to his own wish. After two weeks he again reported to the hospital. Symptoms of a pericarditis were found. At operation the pericardium was filled tautly with a serous-hemorrhagic exudate. A cure was effected in a short time and the patient performs hard labor, occasionally experiencing lancinating pains in the cardiac region. Two years later the findings were normal, including the electrocardiogram.

CASE XXIII.* Death. The patient was a boy of four years, who was attacked by angina due to an infection with *Streptococcus hemolyticus*. On the seventh day after recovery, the temperature rose again and he appeared to suffer from purulent pericarditis. Treatment consisted in the performance of pericardiotomy, after which the greatly distended pericardium rapidly collapsed. After a temporary recovery, death from sepsis occurred four weeks after the operation. The pericardium was not thickened and on its incision, a large quantity (300 c.c.) of a thin greenish-yellow flocculent pus escaped. A rubber drain was placed in the opening. The pus yielded a pure culture of streptococcus, presumably the pathogenic agent also of the throat infection. At autopsy it was shown that the thickened pericardial layers were at no point adherent to each other or agglutinated. The microscopical findings showed a purulent infiltrate of the lungs and also of the superficial layer of the pericardium.

CASE XXIV.[†] Recovery. A man, thirty years old, was brought to the hospital June 26, 1929. He had a high fever, difficult respiration and a painful cough. Examination showed signs of a frank pneumonia of the left lower lobe. There was dullness, increased fremitus and fine crepitant râles. On the sixth day he had a violent delirium followed by hypothermia and an apparent crisis. On July 3 his temperature rose to 102.2°F. and at the same time he had severe dyspnea with a rapid weak pulse.

On July 6 he could not lie down without suffocating. Respiration was rapid, difficult and painful. His face was pale and covered with perspiration. He had severe pain which he localized in the precordial region and epigastrium; also a very slight cough with no expectoration. His lips were blue and congestion of the venous circulation was manifested by the constant distention of the jugular veins.

The dullness at the left base still remained. The precordial dullness was much greater than normal. It extended beyond its usual limits and was continuous below with the hepatic dullness. The liver was large and painful and extended beyond the false ribs. The apex beat could not be perceived. Auscultation showed that the heart sounds were weak and distant. The pulse was 140 and seemed to be intermittent. There were cardiac contractions which were not perceived at the wrist.

A radiographic examination showed an enormous pericardial effusion. It was globular in shape and did not show any pulsations.

On July 10 he was breathless, covered with perspiration; had practically no pulse and seemed to be dying. A puncture made in the fifth left intercostal space near the left edge of the sternum yielded 500 c.c. of a cloudy serofibrinous fluid, and the patient was relieved immediately. The dyspnea decreased, the venous stasis diminished and the pulse became countable. A bacteriological examination of the fluid showed a pure growth of pneumococcus.

On July 12 pericardiotomy was performed under local anesthesia. The cartilages of the fifth and sixth ribs were resected and a large drain was introduced as far as the apex of the heart. The pericardial cavity was irrigated with warm salt solution and a large amount of false membrane was evacuated. The patient

* Van der Hoff, H. L. M. *Nederlandsch Tijdschrift v. Geneeskunde*, 74: 1480-1482 (March 22) 1930.

† Grimaud, L., *Rev. med. d'est., Par.*, 58: 261-271 (April 1) 1930.

was immediately relieved and his condition improved rapidly. Convalescence was complicated by a long persistent tachycardia and a transient edema of the lower extremities.

CASE XXV.* Death. A woman entered the hospital September 13, 1926, with fever, cough, cyanosis, vomiting and dyspnea. The last menstruation was May 15 but on August 6 the patient began to bleed. Three days later she was delivered of a four months' pregnancy and was curetted. Four days after this she had a chill and was again curetted. The next morning she awakened with a severe pain at her heart and had difficulty in breathing. She became gradually worse, had fever and began to vomit.

The patient was cyanotic and breathed rapidly and laboriously. The pharynx was red and the breath foul. There was bronchial breathing, increased vocal fremitus, dullness in the lower lobe of the left lung, and the cardiac dullness was increased on both sides. The heart sounds were muffled but the apex beat was apparently within normal limits.

September 14, the x-ray revealed an enormously widened pericardial shadow. Under local anesthesia the patient was needled three times for pericardial fluid and nothing but blood obtained. The next afternoon she appeared moribund, had an imperceptible pulse, a cold, wet, blue body, labored respiration and was unconscious. Emergency paracentesis was resorted to. A drop of blood appeared, then 115 c.c. of thick yellow pus. As this was removed the patient's color and senses returned. Her pulse was again obtainable and she rested decidedly more easily. By x-ray there was no diminution in the size of the pericardial shadow. On the following morning pericardiectomy was done under gas anesthesia. The heart was found adherent to its sac, walling off a small empty pocket posteriorly. A rubber drain was left at the edge of the pericardial incision.

The patient left the operating room in fair condition but at 5 P.M. her pulse became weak and her respiration difficult. She died two hours later.

The autopsy showed uterine involution; suppurative pericarditis (*streptococcus*) with adhesions and dorsal abscess formation; suppurative mediastinitis pointing beneath the

xyphoid; multiple infarcts of the right lung and kidneys; serofibrinous pleuritis (right); cloudy swelling of the heart, kidneys, liver and spleen.

CASE XXVI.* Death. A female child of six and a half years was admitted June, 1925 with pain in the epigastrium, dyspnea, and fever. The onset seven weeks previously with an upper respiratory infection and otitis media was followed by pneumonia. On admission the pulse was 160, respirations 75, and the child was pale, cyanotic, and very restless and dyspneic.

Examination revealed dilated superficial veins, shallow labored breathing and a flat note over the entire chest. There were fine râles over the left upper and tubular breathing in the right lower portions of the chest. The left border of the heart extended to the posterior axillary line, the right to the right anterior axillary line. The apex beat was not visible or palpable and the cardiac sounds were muffled. The liver was down 5 fingers.

A diagnosis of pericarditis with effusion, interlobar empyema, and pneumonia was made. The urine was negative, the red blood cells numbered $3\frac{1}{2}$ million and the leucocytes 24,000.

Radiographic examination showed the heart practically filling the chest below the fourth rib and extending to the second rib posteriorly. There was increased density throughout the right lung. Reexamination after removal of 60 c.c. of fluid from the left chest with air replacement outlined a fluid level in the pericardial sac.

The child's condition became very critical and a pericardiectomy was done by the method of closed catheter drainage. The pericardial cavity was irrigated with saline and later with Dakin's solution.

For a few days there was a rapid improvement but this was terminated by mastoiditis, mastoidectomy and *streptococcus* septicemia. A fatal outcome resulted and necropsy was refused.

Both the pericardial exudate and the blood culture grew *Streptococcus hemolyticus*.

CASE XXVII. Recovery. *Idem.* A male negro, aged thirty-one years, was admitted January, 1926, with a temperature of 103.4°F. , a pulse of 100, and respirations 44. The onset two days previously was marked by pain in the chest, weakness, and a choking sensation.

* Harloe, R. F. *Long Island M. J.*, 22:633-640, 1928.

* Welch, H. J., and Welch, H. S. *J. Missouri M. A.*, 25: 65-67,

There were signs of consolidation at the base of the right lung.

On January 20 a pericardial friction rub was heard and three days later definite signs of a pericardial effusion developed. The cardiac borders reached on the left 12 cm. and on the right 6 cm. from the midsternum. This was corroborated by x-ray examination and the shadow was characteristically flask-shaped. There was increased density of the lower lobe of the right lung.

On January 30 pericardiocentesis yielded 130 c.c. of pus which cultured *Streptococcus hemolyticus*. Two days later a closed pericardiectomy was done and the pericardial cavity was irrigated with salt solution.

Convalescence was complicated by a phlebitis of the right subclavian vein, but slowly became complete with no evidence of residual cardiac damage.

CASE XXVIII.* Death. A male, seventeen years of age with onset of pain in the lower left chest had a non-productive cough, temperature 102°F., and signs of lobar pneumonia of the left chest. Ten days later signs of fluid developed and the left pleural cavity was drained by the closed method. Twenty-one days after onset, chills, dyspnea, cyanosis, and pain over the liver (enlarged) developed. The heart sounds were distant and the area of cardiac dullness was enlarged. Edema of the legs and dilatation of the superficial veins of the thorax followed, and the roentgenograms were typical.

Pericardial aspiration brought considerable relief. The fluid contained pneumococci. On the following day pericardiectomy was done by resection of the costal cartilage of the sixth rib. The pericardium was exposed and perforated with a gall bladder trochar, with the escape of 600 c.c. of pus. A catheter was fixed within the pericardial cavity with a purse-string suture and immersed in a vessel of antiseptic solution. For four days there was marked improvement and then overwhelming sepsis caused death seven days after operation.

CASE XXIX.† Death. A married woman of twenty years, who for two weeks had had bronchopneumonia of the apex and left lower lobe, developed marked and extensive dullness over the precordium. The heart sounds were feeble and distant and seemed to become more

so on inspiration, and the pulse was 106. An x-ray examination showed a large water-bottle pericardial shadow; also a shadow in the upper two-thirds of left lower lobe. The patient had markedly embarrassed breathing and was obviously critically sick. The white blood count was 20,800, polymorphonuclears 87 per cent.

October 10, a left pericardial puncture in the fourth interspace yielded 480 c.c. of turbid fluid and on October 24, a pericardiectomy was done with the evacuation of 620 c.c. of thick purulent fluid. On dissecting back the left breast, an abscess was found beneath the fascia, a result of the puncture made fourteen days previously.

On December 6 the patient made her exodus with the final diagnosis: (1) Pneumonia, (2) suppurative pericarditis, (3) chronic passive congestion of liver, and other viscera.

CASE XXX.* Recovery. A girl of eight years developed purulent pericarditis (*streptococcus*) following erysipelas. Drainage was established through the epigastric route and the patient rapidly recovered. One month after operation she was again enjoying normal health and the physical and x-ray examinations indicated no evidence of pericardial adhesions.

CASE XXXI. Death. *Idem*, 1929. A boy, fourteen years of age, had been treated by repeated aspiration of serosanguineous fluid from the pericardial cavity without benefit. Tube drainage was instituted through a Larrey approach and the patient showed considerable improvement with diminution of the cyanosis and dyspnea for a few hours. However, collapse and death ensued thirty-six hours after operation.

CASE XXXII. Death, *Idem*, 1930. A child aged ten years developed a purulent pericarditis (*pneumococcus*) following pneumonia of the left lung. The temperature ranged from 39° to 40°C. and asphyxia seemed imminent. Clear fluid was aspirated from the left pleural cavity and a pericardiectomy was done through the epigastric route. The temperature persisted, clear fluid was again withdrawn from the left pleural cavity and signs of pneumonic involvement were found in the right lung. On the fifth day after operation death occurred from a copious secondary hemorrhage from the wound. Postmortem examination established the source of hemorrhage from the

* Bowers. *Arch. Surg.*, 19: 301-308, 1929.

† Brenizer, A. G. *Southern M. & S. J.*, 91: 468-471.

* Fèvre, M. J. *de Chir.*, 35: 656-77, 1927.

internal mammary vein and demonstrated complete drainage of the pericardial cavity.

This collection and analysis does not include 3 cases which have been reported, for the reason that they were not treated by pericardiotomy, but by aspiration only, with complete recovery in two instances.

Capogrossi described a case of pneumococcus pericarditis following pneumonia, which was treated by pericardiocentesis with a rapidly fatal result.

Dujol's patient completely recovered after a single evacuation of the pericardial cavity by needle aspiration. His patient was a woman, aged twenty-five years, with a staphylococcus septicemia following an abortion. After removing 200 c.c. of purulent fluid, the patient was promptly relieved and showed no further tendency to reaccumulate an effusion.

A similar experience was reported by Aritzenius. A perfectly healthy girl of eleven years fell and sustained an injury to her chest. On the following day, she developed a fever and a few days later a delirium and evidence of bronchial pneumonia. In the second week an empyema of the left pleural cavity was drained by rib resection. The temperature did not subside, and the area of cardiac dullness remained large and progressively extended to the right. Consequently, a pericardial puncture was done and seropurulent fluid was evacuated. Staphylococcus aureus was demonstrated in this exudate. Without further treatment directed to the pericardium, the patient made a complete recovery.

SUMMARY AND CONCLUSIONS

1. Purulent pericarditis is essentially a complication of other diseases and is met principally in childhood and early adult life.

2. That its presence has so frequently been unsuspected, until disclosed by post-mortem section, would indicate a lack of due consideration of this complication.

3. Quite consistently characteristic clinical pictures and x-ray findings have been observed in all reported cases. Pericar-

diocentesis or exploration readily establishes the diagnosis.

4. A consideration of the relative mortality rates of 45 per cent in cases receiving surgical drainage and approaching 100 per cent in undrained cases presents no question for decision as regards treatment..

5. Insufficient data have been accumulated to make a comparative evaluation of the various methods of drainage. The advantages of the air-tight closed operation have been demonstrated experimentally but unfortunately it is a rather blind procedure and does not permit exploration. The use of drainage material and irrigations in open drainage, may be guided by the nature of the exudate and offending micro-organisms but it would seem highly desirable to avoid placing any foreign body within the pericardium. Reliance upon the expulsive action of the constant motion of the heart and upon postural drainage has proved as effective as any other method in the small group of cases so treated.

TABLE III
TYPES OF DRAINAGE

	Recov- eries	Deaths	Total
1. Open drainage with tube or wick (rubber, gauze, etc.).....	66	46	112
2. Open drainage with no tube or wick.....	9	3	12
3. Closed catheter drainage	2	4	6
4. Not stated.....			41
5. (Open postural drainage)	(4)	(0)	(4)
	77	53	171

6. The compiled reports contain surprisingly few cases with symptomatic evidence of resultant adhesive pericarditis or other heart damage.

The frequent multiplicity of lesions and indefinite early histories of many records made identification of the primary focus in many instances somewhat uncertain.

The bacteriological classification was based upon and includes the reports of the bacteriology of blood cultures or of the pericardial exudate removed at operation, pericardiocentesis, or post mortem.

[For References see p. 65.]

A NEW MODIFICATION FOR THE INJECTION METHOD OF ARTERIOGRAPHY (INJECTION IN REFLUENCE)*

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IN arteriography there are two different methods:

1. Percutaneous injection.

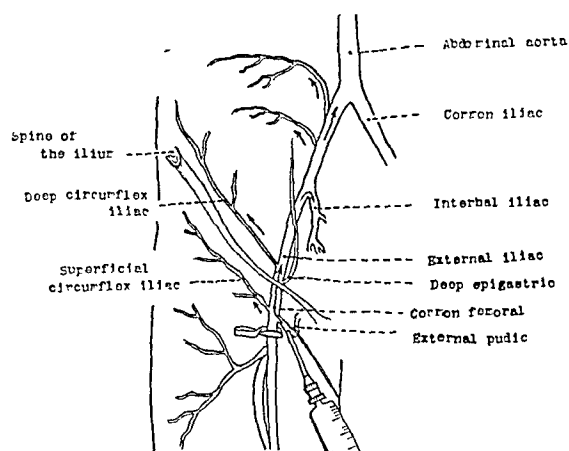


FIG. 1. Diagram of injection method in refluxence. SI, Spine of ilium. DCI, Deep circumflex iliac artery. SCI, Superficial circumflex iliac artery. AA, Abdominal aorta. CI, Common iliac artery. II, Internal iliac artery. EI, External iliac artery. DE, Deep epigastric artery. CF, Common femoral artery. EP, External pudic artery.

2. Incision method (surgical method).

Of these two, the percutaneous injection has been carried on in human beings since the days of the discovery of salvarsan. Knauer, Benedik and others used this method for the treatment of brain syphilis by the injection of salvarsan solution into the internal carotid artery. And Moniz first tried this method for arterial encephalography. But in this percutaneous injection the contrast media is injected in diluted form into the blood vessel and the result is not always good. Moreover the opaque substance must be used in a strong concentration. For example, Dos Santos has put a hundred per cent solution of sodium iodide to good use in aortography.

In the incision method, on the contrary, arteries are exposed and the injection

carried on under direct vision. Therefore, we can utilize with the incision method deep arteries which are inaccessible for percutaneous injection, and here the incision method is superior to the percutaneous method in the certainty and excellence of the result.

We may further classify the incision method into:

(a) Puncture of the trunk of the artery.

(b) Puncture of a small branch of the arterial trunk (our method).

a. Puncture of the Trunk of the Artery. As usually known, an arterial clamp is applied on the artery, the trunk of the artery is punctured, and the injection is begun. This is called "arteriography after the closure of the blood stream" (*arteriographie en circulation bloquée, Arteriographie in abgesperrter Blutzirkulation*).

As in Mauculaire's case, with puncture of the arterial trunk we are not only compelled by greater bleeding sometimes to ligate the artery, but we are really prevented from using it for patients with arteriosclerosis.

b. Puncture of a Small Branch of the Arterial Trunk. To remedy these deficiencies, we inject a branch of the artery. As we have already written, in arterial encephalography we use the superior thyroid artery. In arteriography of the extremities, puncture of the following branches is made: the superior or inferior ulnar collateral artery in the arm; the external pudendal artery in the thigh; the lateral or medial superior artery of the knee in the fossa poplitea.

From the standpoint of direction of stream of the opaque substance injected, we have decided to name this above-stated method "arteriography in current" (*l'ar-*

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terigraphie par injection descendant, Arteriographie durch absteigende Füllung). In this injection "in current," peripheral

The practical application of this new method is illustrated by the following brief reports and plates.

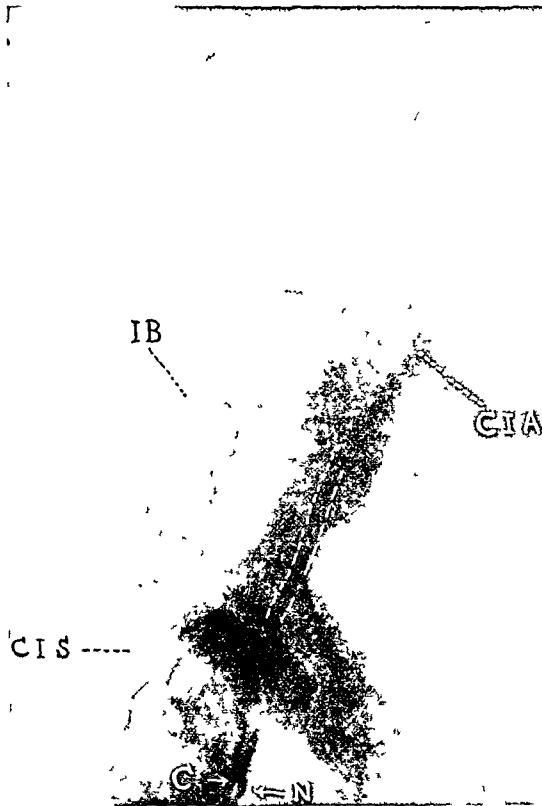


FIG. 2. Arteriogram of arteries in pelvic cavity, obtained after injection of l'ombre in reflux. c, Clamp on femoral artery. N, Needle. cis, Arteria circumflexa ilium superficialis. IB, Iliac branch of iliolumbar artery. CIA, Common iliac artery.

arteries from the punctured point and both deep and superficial venous systems are included in the radiographic studies. But we cannot possibly visualize the arteries of the body trunk such as axillary artery, subclavian artery, arteries in the pelvic cavity, etc. except by Dos Santos's method of aortography.

Therefore we have originated a new method of injection, as follows: The artery is exposed and the arterial clamp applied; then a certain amount of the opaque substance is injected at a point proximal to the arterial clamp, in reflux of the blood stream. This is called "arteriography in reflux" (*l'arteriographie par injection ascendant, Arteriographie durch aufsteigende Füllung*).

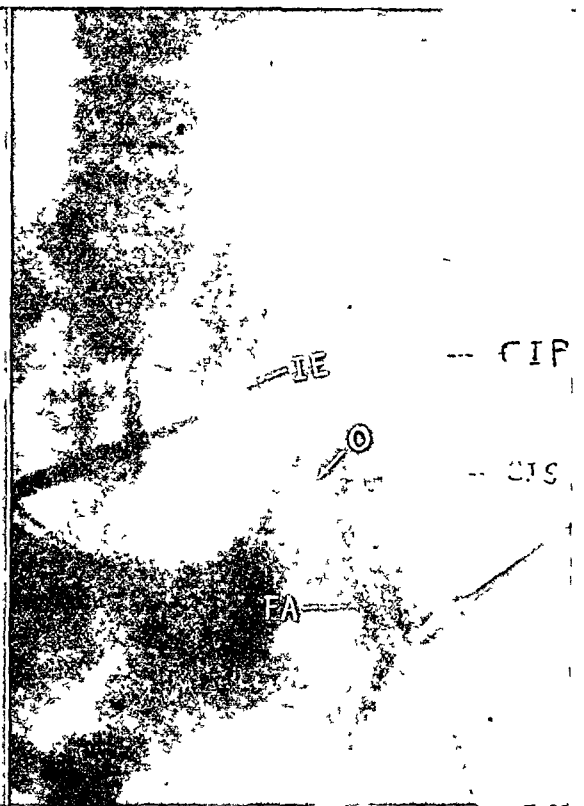


FIG. 3. Arteriogram of pelvic cavity obtained with injection of l'ombre in reflux. FA, Femoral artery. O, Obstruction of external iliac artery. IE, Inferior epigastric artery. CIP, Deep circumflex iliac artery. CIS, Superficial circumflex iliac artery. Both inferior epigastric and deep circumflex iliac arteries are used as collateral blood circulation.

CASE I. T. N., aged sixty-two, male. Diagnosis: Buerger's disease and arteriosclerosis.

Thirty years ago he worked in a district of severe cold. Since then he has felt a coolness in his lower extremities. Last year a cyanosis, then an ulcer of the right hallux, occurred. On admission to the hospital, May 19, 1930, it was noted that the left lower extremity showed marked swelling below the knee, colored violet-black in some places, with an ulcer in the hallux. One could not feel the pulsation of the femoral, popliteal and anterior tibial artery. On the right side there was no ulcer but we felt the thigh cool. Pulsation of the femoral artery could be felt directly below Poupart's band. There was no pulsation of the popliteal or of the anterior tibial artery. In this case "arteriography in current" was

performed by injection of the external pudendal artery after closure of the femoral artery. This roentgenogram showed that in the right

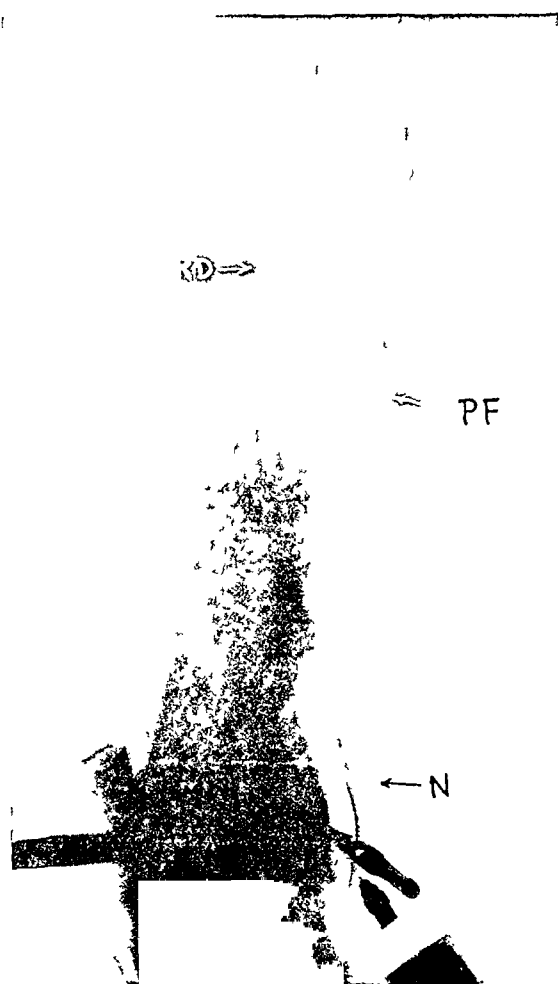


FIG. 4. Arteriogram of collateral circulation in case of obstruction of femoral artery. RD, Descending branch of circumflex lateral femoral artery. PF, Deep femoral artery. N, Common peroneal nerve (neurographic figure). Descending branch of circumflex lateral femoral and deep femoral arteries are used as collateral circulations.

side the femoral artery was obliterated and the ramus descendens of the deep femoral artery dilated and coiled then flowed into the popliteal artery. In the left side the femoral and popliteal arteries were not obliterated, but the lumen of these arteries was very irregular and thin.

We used in this case "arteriography in reflux," our new method; using on both sides l'ombre, a fine iodized oil emulsion,

into the femoral artery "in reflux" to the blood stream after closure of the femoral artery (Fig. 1). This arteriogram showed that on the right side (Fig. 2) the opaque substance filled the common iliac artery up to the abdominal aorta (A. hypogastricum, A. iliolumbalis, A. epigastrica inferior and A. circumflexa ilium profunda, etc.) while on the left side it is noted that, as in Figure 3, the external iliac artery was obliterated, and as a collateral circulation the last intercostal artery and internal mammary artery ran into the femoral artery through A. circumflexa ilium profunda and A. epigastrica inferior. In Figure 4, which was taken by injection in reflux through the lateral superior artery of the knee in the right poplitea, the following collateral circulations are seen: PF is the collateral circulation from A. femoris profunda, RD is ramus descendens of A. circumflexa femoris lateralis. N shows the common peroneal nerve which was visualized in the film by neurography. Neurography is carried out by injection of l'ombre perineurally and intraneurally. There are no functional and pathological changes of the injected nerve.

CASE II. T. Y., aged forty-eight, female. Diagnosis: Aneurysm of axillary and subclavian artery.

For ten months, she has been suffering from neuralgic pain in the right upper extremity. For four months, a swelling of hen's egg size has been present in the right axilla and it did not disappear in spite of all antiluetic therapy. On admission into the hospital on Nov. 15, 1930, it was noted that the tumor in the right axilla was fist-sized and pulsating. The dilated veins on the skin overlying the tumor are seen. The right radial artery was very feeble; in the outer side of the upper arm and on the dorsum of the hand there was hypalgesia. After temporary resection of the right clavicle, double ligatures of the artery were performed, one proximal and the other distal to the tumor. The roentgenogram which was taken after operation by injection into the tumor cavity (Fig. 5) showed that the inner wall of the tumor was irregular and the cavity of it was

small in comparison with the tumor itself, owing to the blood clot in it. In spite of the ligation of the main artery to the upper

scapulae and A. transversa colli. Through these, the upper extremity has been nourished.

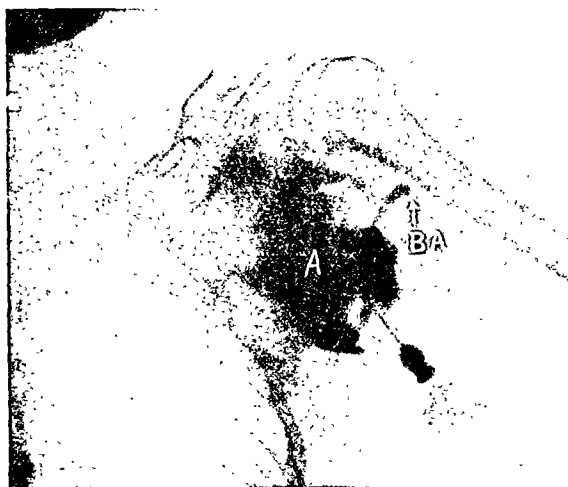


FIG. 5. Aneurysmogram by puncture of aneurysmal cavity after ligation of artery. A, Cavity of aneurysm. BA, Brachial artery, ligated.



FIG. 6. Collateral circulation in patient with aneurysm. B, Brachial artery. L, Ligation of brachial artery. CHP, Arteria circumflexa humeri profunda, which was used as collateral blood circulation. Arrow indicates direction of injection of l'ombre.

extremity we could note nothing important and there were no noticeable symptoms caused by disturbance of the arterial circulation.

The following broad fact explains this. In the brachial artery exposed in the elbow, arteriography by injection in refluent was performed. The roentgenogram, as seen in Figure 6, showed that the brachial artery disappeared at the axilla but at that point a fairly thick artery ran up to the shoulder. This artery is the A. circumflexa humeri posterior which as a collateral circulation anastomosed to A. transversa

CONCLUSION

We have demonstrated a new method of arteriography by "injection in refluent." By this method we are able to visualize the arteries in the pelvic cavity, obstruction of the external iliac artery, and the collateral circulation in a patient with a large aneurysm of the subclavian artery. This injection method "in refluent" will open the way for practical clinical visualization of the arteries of the trunk of the body, such as the subclavian artery, and the arteries in the pelvic cavity.



A METHOD OF VENTRICULAR PUNCTURE*

ALBERT S. CRAWFORD, M.D.

DETROIT, MICH.

PUNCTURE of the lateral ventricles has become a well-recognized procedure and is indicated under the follow-

many blind thrusts. Performing it without drapes facilitates the finding of the proper angle of approach by "sighting" the needle.

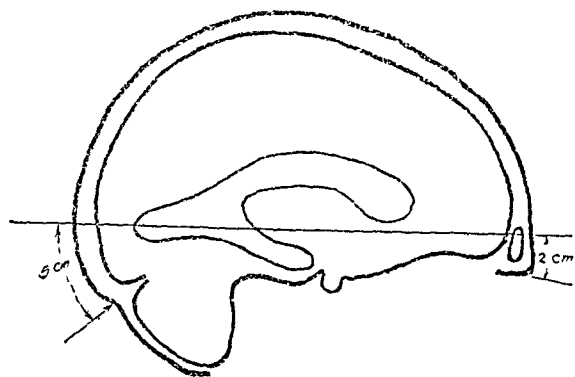


FIG. 1. Composite tracing of a large number of normal ventriculograms. Shows horizontal plane chosen for direction of trocar.

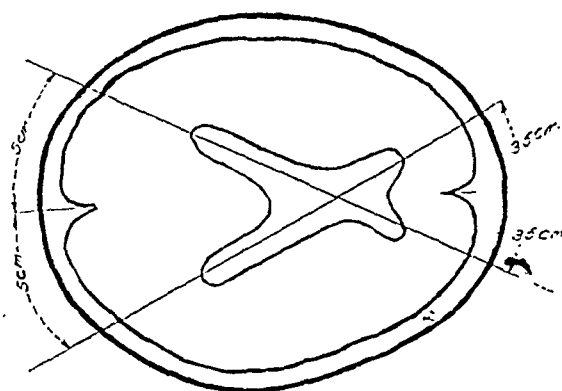


FIG. 2. Composite tracing of normal hardened brains with ventricles filled with air. Shows vertical plane chosen for direction of trocar.

ing conditions: (1) as an aid in localizing intracranial lesions (ventriculography or ventricular estimation of Dandy); (2) as a safer means of obtaining diagnostic spinal fluid when there is likely to be a blockage in the circulation between the third and fourth ventricles; (3) as a safety valve to reduce pressure above such a block; and, (4) as a means of drainage, irrigation, or instillation of antiseptics or sera in cases of meningitis.

It is fairly generally accepted that ventricular puncture is a major surgical procedure and not to be undertaken lightly and only to be done by one who is able and ready to follow up with a craniotomy if it becomes necessary.

To see an experienced operator thrust a trocar free-handed into a ventricle looks like a simple procedure and it very often is as it appears. But, there are circumstances when it can become very difficult, and at times the ventricle is not reached even after

But, there are some who do not care to risk this method and its potential dangers of infection, and we have found it difficult sometimes to sight accurately with the patient draped.

Not being satisfied with the procedure we had been using, we began looking for a method which would permit us to be reasonably certain of hitting the ventricle, with an apparatus which would hold the needle in place, and with the field adequately protected against contamination. We experimented with a number of different devices but finally hit upon this one which has proved very satisfactory during the last five years. A number who have witnessed it have urged that it be described, so this is done with the hope that it may prove of some value to others.

The problem divided itself into several phases: (1) to determine the best point of approach; (2) the proper angles for the needle to take; (3) to develop an apparatus

* From the Neurosurgical Division, Henry Ford Hospital. Submitted for publication November 4, 1931.

to guide the needle, and when desired to hold it in place; the same apparatus to be used bilaterally, if desired.

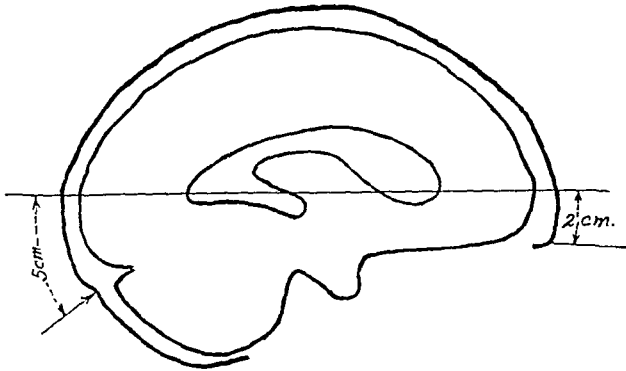


FIG. 3. Composite tracing of normal hardened brains, ventricles filled with air. To check those made by tracing normal ventriculograms.

As to the first problem, the best point of approach, all have generally agreed with Dandy that the vestibule of the posterior horn is the largest target, and likely to be the most constant in location. It is best approached through the fairly "silent area" in the occipital lobe which is lateral to the optic cortical centers, and behind the sensory centers. The different operators vary a little as to the points of approach

superimposed tracings, made a composite drawing (Fig. 1) of the lateral view. For the view from above, we took a number of

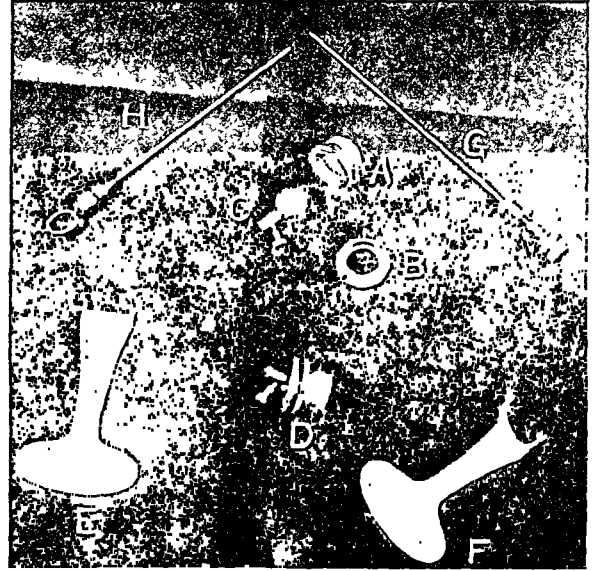


FIG. 4. Trocar guide-and-retention device. A, Outer ring. B, Ring cap. C, Ball guide. D, Device assembled. E, Straight wrench for inserting (A). F, Spanner wrench for applying (B). G, Smaller trocar we use. H, Old larger trocar commonly used.

normal brains hardened in formalin, and took x-rays after the ventricles were filled with air. A composite tracing was made of



FIG. 5. Wire loop director attached to ball guide. Its proper direction is maintained by locking the guide with the ring cap.



FIG. 6. Trocar locked in place in guide.

and the angles, but in general they use the same target.

In order to work out theoretically the points and angles of approach best for us, we studied a number of films of previous ventriculograms of normal brains, and by

these (Fig. 2). This latter material was used to check the lateral views (Fig. 3). The best starting point seemed to be the internal occipital protuberance, as it seemed more constant, and it can always be related to some external bump or groove by study of a previous x-ray of the skull. The most favorable horizontal plane seemed to be

one that was 5 cm. up from the protuberance behind (Figs. 1 and 3), and 2 cm. above the supraorbital ridge in front. The

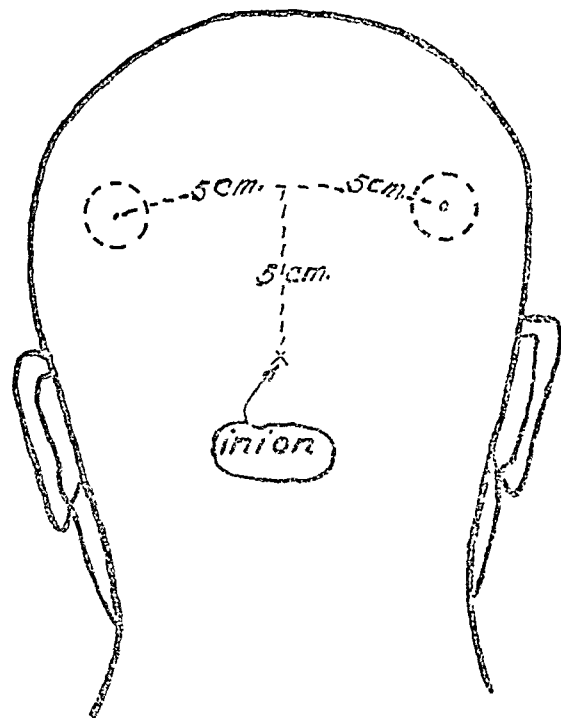


FIG. 7. Diagram of suboccipital region to show position of trephine openings in relation to inion (or internal occipital protuberance).

best vertical plane seemed to be 5 cm. from the midline behind, and 3.5 cm. from the midline in front (Fig. 2). These were checked against at least one hundred actual ventriculograms, and this method has been our routine for five years with satisfactory results.

As to a guide and retention device, we had made and tried out several with adjustable arms fastened to a headband, but found that the simplest and most rigid was one which anchored directly to the skull by screwing into the trephine openings.

Figure 4 shows the device, taken apart, (A, B, and C), and assembled (D). The outer ring (A) is threaded outside to screw into the trephine opening, and inside to receive the ring cap (B) which, when screwed down, clamps the ball guide (C) to maintain the desired angle. This latter has a setscrew

to hold the needle while in the ventricle. The wrenches (E) and (F) are for applying (A) and (B) respectively. It should be

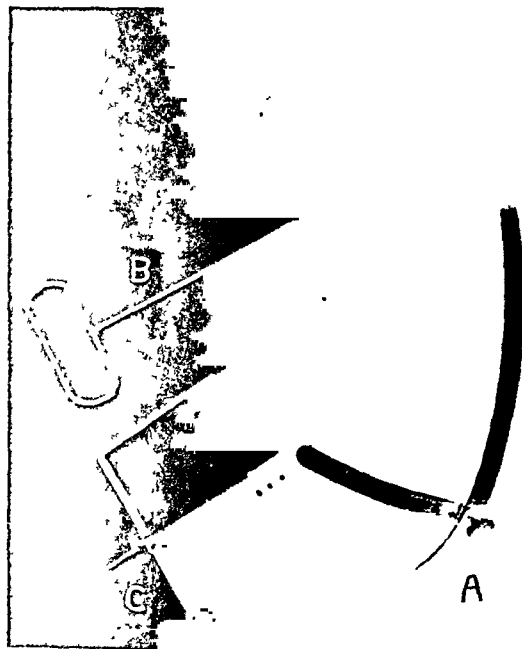


FIG. 8. A, Measuring device for placing marks for position of trephine openings. B, Hand marker used to mark skull before incision has been made. C, Sliding retractor, useful for any small operation.

pointed out that the trocar (G) we use for brain puncture is one we made here, and is of 17 gauge needle tubing, with a closed tip, and two small holes behind the tip. This needle results in less trauma than the larger one commonly used, (H). It is fitted for Luer connections.

Figure 5 shows a wire loop guide which we use to give the ball guide its proper direction. It is removed when the ring cap has been screwed down to "set" the ball guide in its place. Figure 6 shows the needle introduced and held in place by the set-screws on the ball guide.

The procedure briefly consists of three steps: (1) obtaining the landmarks and marking the points; (2) applying the guide-and-holding devices; and (3) the ventricular punctures and intraventricular maneuvers. The accurate placing of points is essential. The starting point (the point on the skin corresponding to the internal occipital protuberance) can be located by

relating any palpable eminence or depression to the desired point by means of a lateral skull plate taken before the opera-

skull for greater accuracy by a hand auger marker (Fig. 8B) after the field has been prepared. We have found the easiest way

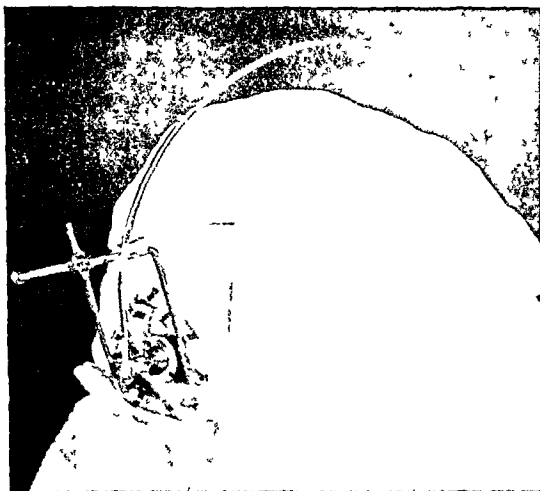


FIG. 9. Set-up at operation: Head covered with helmet, wound held open with small retractor, wire loop director clamped in place ready for removal of director.



FIG. 10. Set-up at operation. Needle is in ventricle and connected with manometer and syringe by means of a three-way valve.

tion. Then the measurements (5 cm. up and 5 cm. to either side of the midline) (see Fig. 7) can be made by hand or by the assistance of such a measuring device as

to drape the head is by covering it with a sterile helmet made of heavy unbleached sheeting, which has an opening in the sub-occipital region for the operative field (Fig. 9). The head is held in the upright

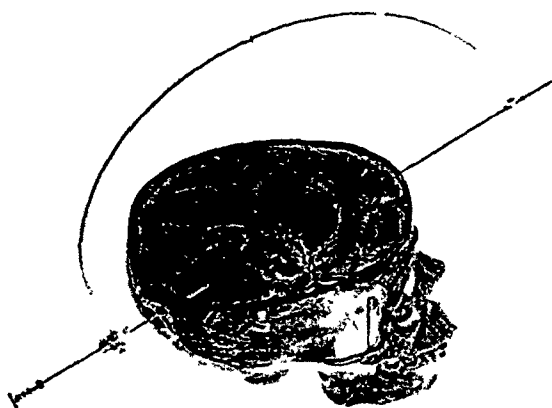


FIG. 11. Wire loop director devised for use where head is not draped or where skin is closed over trephine hole. Apparatus is held immobile by means of short pin posteriorly and long pointer anteriorly until trocar has entered ventricle.

we use (Fig. 8A). The marks can be made with a knife scratch or painted on with silver nitrate stick, or brilliant green. These marks can then be transferred to the



FIG. 12. Wire loop director with hinged-groove guide opened, permitting removal from needle which is in ventricle.

position by the adjustable headrest with pads against the neck under the occipital region. This permits of bilateral puncture, with rotation of the head at will, and by tilting the table the head can easily be lowered to any level to completely empty the ventricles.

After the skin has been blocked with novocaine and the marks have been transferred to the skull, the incision is made and Michel clips attaching the stockinet-cover for hemostasis and protection¹ the wound is kept open with the small self-retaining retractor shown in Figure 8c. (This has also proved of value as a retractor in all small exposure operations such as subtemporal decompression, trephining, etc.) After the trephine hole has been made with a medium-sized burr, and the dura inspected and nicked with a knife; the guide is screwed into the trephine hole, the wire loop guide (Fig. 5) is attached and the guide ball properly set (Fig. 9); then the wire guide can be removed and sent to be resterilized, preparatory for use on the other side. All is then ready for the needle thrust. The syringe, three-way rubber tube connection, and monometer are put in readiness and connected with the needle (Fig. 10), after it has entered the ventricle and the setscrew has been tightened, fixing the needle in place. One can then proceed to empty the first ventricle, or repeat the procedure on the other side and place a guide and needle in the opposite ventricle. One is then prepared for the simple emptying procedure, or any maneuvers he may wish.

The criticism may be made that this is too complicated a procedure to be justified as a routine. It may be unnecessary for experienced operators, and where no diffi-

¹ Crawford, A. S. Craniotomy incisions without forceps. *Arch. Surg.*, 17: 472-4, 1928.

culties are to be encountered; but we feel certain that we have been saved some failures and have avoided some unnecessary trauma to the brain by sticking to a mechanically accurate procedure in preference to the freehand method. Also, this permits of simultaneous bilateral work which at times is of value. In over 200 ventricular punctures, the only ones we have missed are those where either the ventricle was displaced or some error was made in placing of the marks. The latter should be very rare if care is exercised.

The flexible cross-shaped measuring rule (Fig. 8A) and the hand auger marker (Fig. 8B) may be unnecessary refinements, but they do facilitate and make for accuracy and are very useful at times.

A modification of the wire loop guide has recently been devised (Figs. 11 and 12) for use where complete draping is not desired or when the wound is closed as at subsequent punctures. The needle is guided through a groove which lies between two small metal plates which are hinged together and can be opened by loosening a setscrew. This groove points accurately towards the opposite pin which is held against the outer target. The whole loop is sterilized for use, but only the rear part need be kept so during the procedure. As soon as the needle has struck the ventricle the guide can be removed, the needle being left in place (Fig. 12). With such a device any point of approach and any target can be used. The needle must of course be held in place by hand with this method.



THE SIGNIFICANCE OF LABORATORY STUDIES IN GASTRIC AND DUODENAL ULCERS*

J. WILLIAM HINTON, M.D., F.A.C.S., AND SOPHIE FRANKEL, B.S.

NEW YORK

THE results of complete laboratory work done in 141 ulcers by one of us (S. F.) have been reviewed and the findings evaluated. The cases admitted to our clinic have had positive diagnoses made before being registered, as this is a "refer clinic" and the patients either come from the 4th Medical or Surgical Division, Bellevue Hospital. The majority have received no previous treatment but a few have had medical treatment in other institutions, and some have been operated upon elsewhere before coming under our observation.

There is a definite laboratory routine for each new patient which consists of an Ewald test meal, complete blood count, urinalysis, Wassermann test, stool examination and blood chemistry, including urea, non-protein, creatinine, sugar, chlorides, calcium and phosphorus determination. Some have had agglutination and sedimentation tests but these are excluded from this report.

In studying ulcer cases one is interested in detecting some means of determining which cases will offer a favorable prognosis under conservative treatment, and also those liable to hemorrhage, and hence to perforate, or cause associated chronic conditions. Chronic cholecystitis has been stressed as a frequently correlated lesion of ulcers, but biliary infections have probably been overemphasized and pancreatic infections minimized as a complication which, when present, offers a poor prognosis for conservative treatment. Hurst and Stewart¹ have stated in their book on "Gastric and Duodenal Ulcers" that an analysis from Leeds of 232 autopsies revealed the pancreas formed a part of the floor of the ulcer in 24.4 per cent of cases,

and the liver only 4.3 per cent. They likewise report a clinical series from Leeds of 183 cases of partial gastrectomies in which the pancreas formed a part of the floor in 19.7 per cent of cases, and the liver 2.2 per cent. One can see from this report that pancreatic involvement, in ulcers, is present in a high percentage of cases.

We have several postoperative cases of chronic pancreatitis associated with ulcers that are being followed in the clinic. It has been our belief that pancreatic involvement is the one associated lesion that should be diagnosed so as to determine when conservative treatment shall terminate and surgery be recommended. With that in mind a review of the complete laboratory work has been undertaken with the hope that some aid could be obtained from this study which would influence the prognosis in the difficult cases.

Of this group, which numbered 141, there were 126 unoperated cases which consisted of 108 duodenal ulcers, 14 gastric, 1 pyloric and 3 double ulcers, meaning a lesion in both the stomach and duodenum. There were 15 postoperative cases in the series, these patients having been operated upon in other institutions and coming under our observation for recurrent or persistent symptoms, which included 9 gastroenterostomies, 2 partial gastrectomies, 4 simple closures; and in 1 gastroenterostomy a definite jejunal ulcer was proved. Of the unoperated cases in this group there were 9 cases that came to operation in spite of every attempt to relieve the patients of their symptoms by medical management and of this number one was operated upon for hemorrhage and 8 for persistent pain. Of the 8 cases, 4 had an associated chronic pancreatitis.

Blood Chemistry. We have taken only those cases in which all the laboratory data

¹ Hurst, A. F., and Stewart, M. J., *Gastric and Duodenal Ulcers*. Oxford Univ. Press, 1929, pp. 106 and 189.

* Submitted for publication August 25, 1931.

were complete and this has consisted of non-protein nitrogen, creatinine and sugar by the Folin-Wu method, urea nitrogen by the Van Slyke, chlorides by Whithorn's method, calcium by Kramer-Tisdall and phosphorus by Bell and Daisy method. Our findings were within normal limits in this group and in spite of several cases having a six hour retention varying from one-third to one-half of the motor meal at

Gastric Analysis. The test meal of Ewald and Boas consisted of 2 slices of bread without butter, and $1\frac{1}{2}$ glasses of water, the contents being withdrawn one hour from the time the patient began to eat. In Table I, it will be seen that most of these patients had a high free and total acidity, but in those cases showing satisfactory progress under medical management, the acidity showed relatively little

TABLE I
GASTRIC ANALYSIS

	Duodenal		Gastric		Marginal or Jejunal		Pyloric		Postoperative		Double	
	Free HCl	Total Acid	Free	Total	Free	Total	Free	Total	Free	Total	Free	Total
0-10	1	0	1	0	0	0	0	0	0	0	0	0
10-20	1	1	0	1	0	0	0	0	0	0	0	0
20-30	2	1	1	1	0	0	1	0	2	0	1	0
30-40	9	1	1	0	0	0	0	1	0	1	0	0
40-50	13	6	0	1	0	0	0	0	3	1	0	0
50-60	15	8	2	0	0	0	0	0	2	0	0	0
60-70	27	14	3	0	1	0	0	0	4	4	0	0
70-80	22	22	3	3	0	0	0	0	3	2	0	0
80-90	9	20	2	3	0	1	0	0	1	4	0	0
90-100	4	18	1	3	0	0	0	0	0	2	0	0
100-110	3	8	0	1	0	0	0	0	0	1	1	1
110-120	1	5	0	1	0	0	0	0	0	0	0	0
120-130	1	3	0	0	0	0	0	0	0	0	0	0
130-140	0	0	0	0	0	0	0	0	0	0	0	0
140-150	0	1	0	0	0	0	0	0	0	0	0	0
	108	108	14	14	1	1	1	1	15	15	2	2

the end of six hours, there was no disturbance in the chlorides, and the sugar findings were not altered in any of the cases, although we had 4 cases of chronic pancreatitis proved by operation.

Urinalysis. In this series there were no cases of glycosuria, but Hurst and Stewart reported 3 cases associated with duodenal ulcers in which the urine became negative after the patient was put on treatment for the ulcer and became symptom-free. This is not in accord with our understanding of chronic pancreatitis, as the lesion is an interlobular affection and does not involve the intralobular connective tissue, or affect carbohydrate metabolism. In a previous report¹ on chronic pancreatitis the sugar metabolism was not disturbed.

¹ Hinton, J. W., Chronic interlobular pancreatitis. To be published.

change. The gastric contents have been studied for the presence or absence of bile and Table II will reveal that 24 cases had bile present, but what part this plays in the prognosis I am not prepared to say.

Complete Blood Count. This offers us a means of detecting an anemia or active infectious process. Great stress has been laid on the high percentage of cases with occult blood in the stools. If this be so then we would expect to find a secondary anemia in a relatively high per cent of cases but in only 3 cases was secondary anemia present, 2 of these having had a recent gross hemorrhage; the other was suffering from bleeding internal hemorrhoids. A number of the cases with the findings of occult blood must bear no relation to the ulcer; in all probability these come from meat in their diet. Leucocytosis

has been stated to occur in active and extensive ulcers but we found only 2 cases with a leucocyte count of 10,000 and one with a count of 13,500, and in all other cases both their leucocyte and differential count was within normal limits.

TABLE II
BILE IN GASTRIC CONTENTS

Bile	Duo- denal	Gas- tric	Mar- ginal	Dou- ble	Post- opera- tive
Plus 1.....	3	0	0	0	0
Plus 2.....	4	1	1	1	1
Plus 3.....	3	0	0	0	0
Plus 4.....	6	0	0	0	4
Total.....	16	1	1	1	5

Wassermann Test. Syphilis is, of course, a fairly frequent disease and syphilitic ulcers have been reported but in this group we found only 2 positive Wassermann reactions, one being gastric and the other a duodenal ulcer; but as neither of these cases has come to operation it cannot be stated whether they were syphilitic in origin or not.

Stool Examination. Although the patients were instructed to bring specimens the majority failed to do so and in only one-third of the total number of cases was the stool examined. Of this number 40 per cent had a positive diagnosis of blood.

Comment. As previously stated each of our cases has had a positive diagnosis of an ulcer before being registered in the clinic and the laboratory work has been done with the hope of obtaining some information that will be of prognostic value. From a review of this series it seems that a diagnosis of ulcer is dependent on the history, physical examination and roentgenological findings. After treatment has been instituted we are still forced to look to the same criteria to determine the progress of the case, as the laboratory work has not been of any very great aid from a prognostic standpoint, although we are continuing, essentially, the same routine. If some method of determining pancreatic infection could be found it would greatly

simplify the handling of borderline cases. Physicians who have had extensive experience with gastric and duodenal ulcer realize that the indications previously given for operation are not true indications for operation, as most of these will respond satisfactorily to medical care, but the one indication for surgery is persistent pain in spite of the different methods of medical care and the pain in the majority of instances is due to an associated chronic pancreatitis. It would seem that until we have some means of detecting the pancreatic involvement associated with ulcers, patients in whom medical treatment is contraindicated will continue to have it, and other patients who can be cured by conservative treatment will be operated upon when surgery is contraindicated.

Rowe and McManus¹ have recently called attention to the importance of doing the galactose tolerance test in cases of hepatic dysfunction and state:

In a series of previous papers the writer and his associates have discussed the normal human tolerance for galactose and a variety of factors exercising influence on its level. The present paper deals with influence of hepatic dysfunction as determined by objective methods on the power of the organism to utilize this sugar. The use of galactose for function testing was first suggested by Bauer in 1906 as a means of evaluating the levels of hepatic activity, but the failure of the subsequent observers to recognize intrinsic sex and age differences and the lack of uniformity in the criteria adopted led to seemingly contradictory results and gradually caused its discontinuance as a test substance. Its use has been revived by the senior author, after a careful and extensive study of the conditions limiting its application, and today it forms the basis of a quantitative vital function test of wide applicability and differential significance.

As the routine work done in this series is of very little aid in prognosticating the outcome it would seem that the galactose tolerance should be routinely tried.

¹ Rowe, A. W., and McManus, M., The metabolism of galactose. ix. The influence of hepatic dysfunction on tolerance. *Am. J. Med. Sc.*, 181: 777, 1931.

SUBMUCOUS PERINEOPLASTY*

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PHILADELPHIA

RELAXATION and laceration of the vaginal outlet produce a condition similar to that of hernia. There is a

overlying or underlying strong fibrous layer is so sutured as to support the muscle and relieve it of strain.

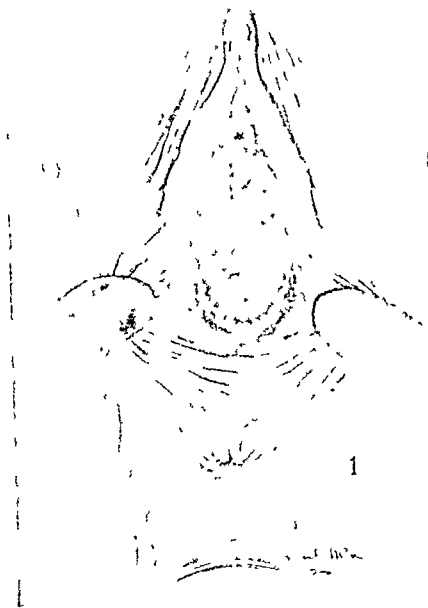


FIG. 1A. Relaxed perineum with lack of support of pelvic contents.

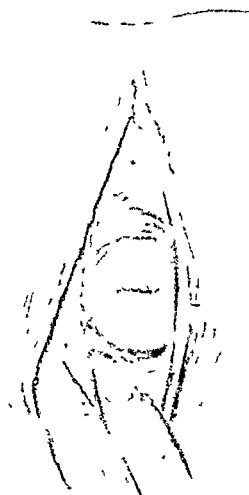


FIG. 1B. Demonstration of margin of levator ani.

canal through which structures from within the body tend to protrude, an orifice or ring and a lack of supporting muscular and ligamentous structures. When the normal supports to the canal are insufficient protrusion occurs. As with a hernia, the restoration of the supporting structures, the obliquity and the narrowing of the canal are important factors in overcoming the abnormality. As with a hernia, united muscle, that it may continue to give support in the perineum, should be backed by a plane of fascia or aponeurosis. Muscular substance is soft and sutures introduced into muscle, under stress, tend to cut through or tear out unless an

Like the inguinal canal, the vagina runs nearly parallel with the skin. The finger passed to the cervix may be palpated by the external hand at the side of the coccyx. Underneath the vagina is slung the great muscular support of the pelvic floor, the levator ani (pubococcygeus) muscle. In the stress of labor, this muscle may be pushed off to the sides of the vagina, with lowering of the pelvic floor. A laceration completely across the levator ani from natural forces is almost unknown. Above the levator is the rectovesical fascia, below the levator fascia. More superficial to the muscle and lateral to the vaginal outlet, lie the two layers of the triangular ligament (fascia trigoni

* From the Surgical Department, Temple University. Read at the 44th annual meeting of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, White Sulphur Springs, W. Va., Sept. 14-16, 1931.

urogenitalis inferior and superior) between which runs the thin and rather inconspicuous transversus perinei profundis. Between

For the vagina and skin a continuous buried submucous and subcutaneous stitch of No. 00 plain catgut is used. For the

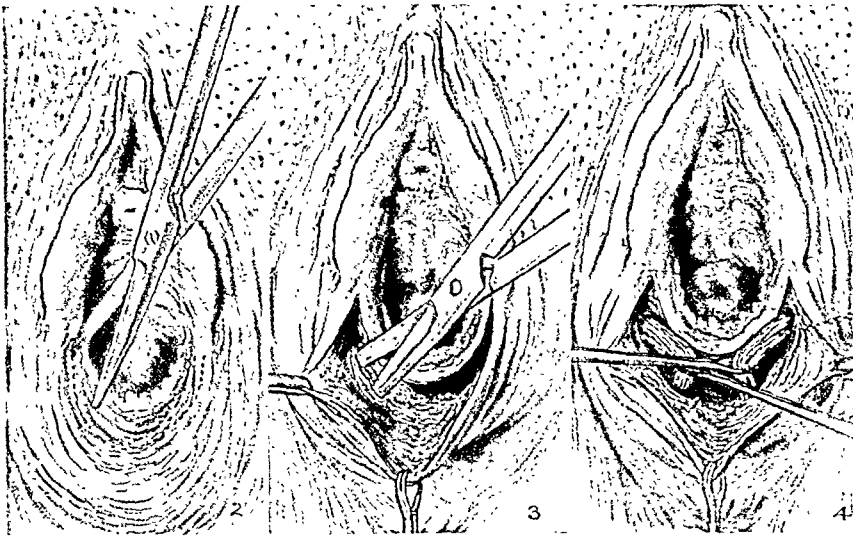


FIG. 2.

FIG. 3.

FIG. 4.

FIG. 2. Transverse incision just below carunculae.

FIG. 3. Incision through the triangular ligament and levator fascia to levator ani.

FIG. 4. Margins of levator ani liberated and withdrawn.

the skin and the lower layer of the triangular ligament is a superficial perineal fascia, the fascia of Colles. There is therefore ample fascia to be used for support to the united pubococcygeus muscle. To unite the layers of fascia and muscle properly, access is best obtained by an incision passing through or near the cutaneous surface.

The shortened and widened vagina should be lengthened and narrowed. The wide edges of the liberated levator ani may then be united under and to the sutured vagina. The supporting fascial layers of the muscle, triangular ligament, the fascia of Colles and the skin may in turn be sutured, giving a very satisfactory perineal support. This type of perineoplasty suggestive of an operation for hernia, I first put into practice in 1902,¹ and have continued to use with but slight modifications until the present time. An adequate exposure of each layer is obtained and from its convenience and efficiency, we prefer to use separate layers of buried catgut suture.

¹ Babcock, Submucous perineorrhaphy. *J. A. M. A.*, May 15, 1909.

muscular and fascial layers, interrupted single or double loop or mattress sutures of No. 0 or 1 chromicized catgut are employed. Others have modified the operation by introducing through-and-through sutures, without, however, changing the essential plan of the procedure. Buried catgut has in our hands given such excellent results and such a desirable emancipation from the difficulties and complications that attend the removal of insoluble sutures, that we have found no reason to discard it.

As a rule, no tissue need be removed from the vaginal wall. The redundant tissue, properly sutured, is useful in elongating the shortened vagina and in restoring those normal folds and sulci which give the vagina an H shape on transverse section, and which are a bar to the development of a rectocele. Of course, there are occasions when the resection of greatly altered or very cicatricial vaginal tissue is desirable. This, however, is not an essential part of the operation.

Early experience indicated that wide, thick surfaces of the levator ani should be

apposed by suture. If the edges of the muscle only are brought into apposition, the muscle will often retract, leaving a thin

Unless there is an unusually large rectocele, any extensive liberation of the vaginal wall from the rectum is unnecessary. Should it

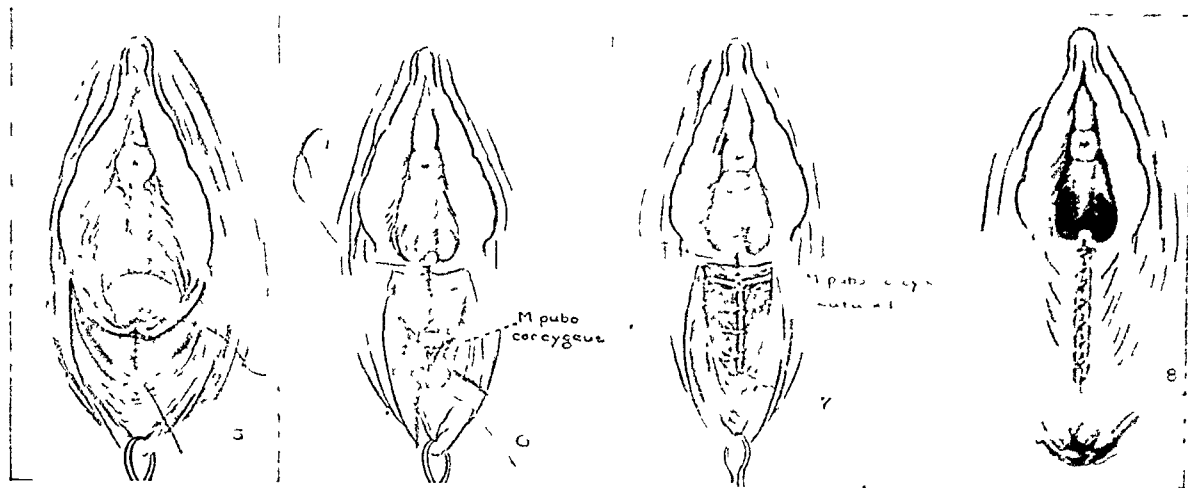


FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 5. Closure of posterior vaginal wall by continuous submucous suture of oo catgut.

FIG. 6. Suture of levator ani muscle.

FIG. 7. Completion of suture of levator ani.

FIG. 8. Triangular ligament and fascia have been united over levator ani by buried sutures. Skin is usually closed by a subcutaneous continuation of suture No. 1.

perineal wall with insufficient support. By uniting the edge with a wide margin from the superior surface of the muscle and with adequate fascial support, we may overcome this tendency.

TECHNIQUE

The parts having been shaved and carefully asepticated, a thick pad of sterile gauze is fastened over the anus. Any necessary preliminary operations upon the cervix, uterus and anterior vaginal wall are first performed. The labia majora are now separated and retracted by the index fingers of assistants and a knife or the sharp point of a pair of scissors is entered into the subcutaneous cellular tissue just internal to the orifice of a Bartholin's gland. The incision is carried around the posterior margin of the introitus, along the carunculae to a corresponding point near the orifice of Bartholin's gland on the opposite side. Laterally, the tissues are separated to the surface of the triangular ligament. Great care should be used in freeing the vagina in the midline to avoid entering the rectum.

be deemed advisable to open the recto-vaginal septum, it is wise to begin laterally, separating the tissues from the sides toward the midline. A tenaculum forceps is fastened to the skin at the middle of the posterior edge of the incision, from which it is permitted to hang as a retractor. An edge of the levator ani muscle is now located between one finger placed against the lateral wall of the vagina and a second finger or the thumb placed in the depth of the corresponding side of the wound. With the edge of the muscle thus located, the layers of the triangular ligament and levator fascia are penetrated by the thrust of a pair of Mayo scissors, the blades of which are then opened and withdrawn. If preferred, the incision may be made by a scalpel. The opening in the fascia is enlarged by knife or scissors, freely exposing the edge of the levator ani muscle, the inferior and superior surfaces of which are well freed by the fingers so the muscle may be grasped by a tenaculum forceps and pulled into the wound. The opposite muscle is similarly located and partially withdrawn

through a corresponding opening in the triangular ligament.

With a curved needle and No. 00 plain catgut the posterior vaginal wall is now united in the midline, beginning with what was formerly the posterior commissure. This continuous suture catches the submucosa only and one end is left long and hangs over the perineum. The middle of the upper border of what was a transverse incision is thus united in a vertical manner, lengthening and restoring the posterior wall of the vagina. If the posterior vaginal wall is very redundant, an additional row of sutures may be applied catching the rectovaginal fascia lateral to the suture No. 1, and so rolling the submucous tissues together that the convexity on the mucous surface of the posterior vaginal wall is accentuated. Suture No. 1 which has thus made a partial submucous closure is now temporarily laid to one side to be completed later.

By mattress or double loop sutures of No. 1 chromicized catgut catching an ample bite from the edges and superior surfaces of the levator ani, a broad surface of these muscles is united in the midline. Posteriorly these sutures may be so applied as to reinforce the trigone, sphincter ani and transversus perinei superficialis. Care should be taken that the levator muscle is not united so far anteriorly as to unduly constrict the vaginal orifice. Some of these sutures also catch the overlying fascia, or submucosa to avoid a "dead space." The new muscular supports will now be observed to cause the vagina, perineum and anus to ascend to a higher and more anterior position so that an anterior deflection of any force from the abdomen toward the pubis will result.

To support the united levator ani the inferior fascial planes are now sutured. The lateral edges of the openings through the fascial trigone and levator fascia are united

from side to side by interrupted sutures of No. 0 or No. 1 chromic catgut, closing the posterior part of the urogenital trigone.

The superficial fascia may now be united by a few sutures of No. 00 plain catgut. The operation is completed by continuing suture No. 1 first as a submucous and then a subcutaneous suture until the posterior angle of the incision is reached, when it is tied to the initial or lower end of this suture.

The knot is permitted to sink under the skin and the ends are cut short. As the various layers of united mucosa, muscle, fascia and skin are compactly bound together, there is little "dead space" and drainage is unnecessary. A hematoma is to be avoided by keeping lateral to the bulbs and by ligating any bleeding vessels. As a rule there is little hemorrhage and ligatures are not required. A narrow wick of gauze is introduced into the vagina, the end of which hangs over the external wound. A sterile supporting pad held by a T-bandage is applied. A catheter is used for two days when the gauze is removed. For wound irritation a 22 per cent yellow oxide of mercury ointment is applied.

The patient usually sits up on the tenth to the twelfth day, and is discharged from the hospital at the end of two weeks; but should resume her house duties only after six weeks. The chief features of the operation are the elongation and narrowing of the vagina without sacrifice of tissue, the clear visual demonstration of each anatomical structure involved, and the accurate suture from within out of each supporting layer. If this is precisely accomplished, the material and method of suturing are considered relatively unimportant. In such an anatomical closure in layers, if the incisions and sutures are carried too far anteriorly an undesirable narrowing of the orifice may result.



A STUDY OF 1200 CERVICES

INCLUDING 589 CASE HISTORIES, 3500 MICROSCOPIC SECTIONS AND THE GROSS SPECIMENS OF 1200 BIOPSIES*

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THIS study is chiefly concerned with the assembled significances of tissue traumata, infection, and repair preceding malignancy as seen in a large series of cases supplying biopsy material.

The wealth of material in this series has been marshalled under the divisions of: Importance of the selection of biopsied tissues; the histopathology; cross section studies of clinical data; considerations of treatment; and summary.

BIOPSIES

In the selection of biopsy material, diagnostic responsibility divides between the clinician and the pathologist. The tissue section may be taken almost haphazardly or after due consideration for the ocular appearance and palpatory information. The ocular examination may be systematized by noting: (a) malformative, (b) vascular, (c) inflammatory, (d) degenerative, and (e) neoplastic changes.

The malformations will include hypertrophy, hyperplasia, atrophy, scars with their indentations, ulcerations and neoplasias. A malformation of position is important, especially that of descensus in disposing to elongation of the cervix and ulceration but not to neoplasia. It is rare to find reported cases of complete descensus and coexisting carcinoma.

Hypertrophies, hyperplasias, ulcerations, atrophies, scarring and neoplasias show frequent associations with vascular changes. The first three are observed accompanying vascular hyperactivity, while the second group have vascular hypoactivity.

The frequency of infections in association with hypertrophy, hyperplasia, ulcera-

tions and neoplasias is well known and should always be kept in mind when inspecting the cervix.

An effective ocular examination will obtain information as to size, color, form, position, discharge, loss of tissue, irritation, presence of cysts, scars, benign and malignant new growths. Additional information is obtained by grouping certain of these observations and proceeding at once to palpation.

In most instances, when the diagnosis is concerned with early stages of malignancy, the cervix should be examined in two imaginary planes. The more nearly normal half should be recognized by combined ocular and palpatory guidance and should receive first attention. The second half can next be subjected to both comparative and exclusive examinations.

The posterior lip will be found more frequently the site of pathology. The margin of the portio is the site of most carcinomas, and the growth in its earlier stages is in most instances shallow, partly eroded or ulcerated, and slightly softer than normal epithelium. The adjoining tissue is denser than normal and the area involved has the appearance of being chronically inflamed at or very near the site of an old laceration. The suspected tissue, if stained, will absorb enough more pigment to make a contrast with the uninvolved tissue about it. If a thin sharp knife is used and section is made through the carcinomatous tissue, the resistance is quite exactly comparable to the resistance of raw potato or carrot tissues. History of previous childbirth, miscarriage, instrumental trauma, gonorrhea or other infec-

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tion with leucorrhea, will always add to the sum total of obtainable data favoring malignancy.

The biopsy section should be 1.5×5 cm. and obtained by cutting from the shoulder of the portio upwards through and past the internal os for about 0.5 cm. In this series of 1200, 253 sections had been taken without inclusions of squamous epithelium and 300 were without gland tissue. The histopathological diagnoses consequently became reduced approximately 25 per cent, or in other words their efficiency reached only 75 per cent, solely because of incomplete biopsy sections. This would constitute a serious omission for clinicians who rely implicitly upon the biopsy diagnosis.

HISTOPATHOLOGY

It is distinctly advantageous in reading a large number of slides to follow certain routine procedures. Accordingly, in this study the stratified epithelium received first attention, the glandular epithelium came second, and the stroma last.

One may observe if all, part or none of the stratified epithelium is of primary (or original) type, or if it is all or part of repair or metaplastic type, and whether young or old repair epithelium, and lastly, if this tissue displayed is part normal, part repair, part metaplastic, or part or all of neoplastic character.

The non-neoplastic stratified epithelium may be strikingly hypertrophic, hyperplastic, deformed, atrophic and keratinized. The hypertrophy will sometimes result from old lacerations compelling piling up of the layer. In certain instances hyperplasia and hypertrophy may result from overactivity of the anterior pituitary lobe. In virgins with a constitutional tendency to hypertrophy of mucous membranes and adenoid tissue elsewhere in the body, the cervix may show marked hypertrophy. Malposition is a frequent cause of cervical hypertrophy and hyperplasia because of long-continued passive congestion. Doubt-

less infection is the most frequent cause of both hypertrophy and hyperplasia.

The loss of stratified epithelium followed lacerations, infections, ulcerations, and erosions.

Metaplasias occurred in the presence of infections, lacerations, erosions, and neoplasias.

Neoplastic, stratified epithelium showed a very strikingly close association with chronic infection, old trauma, scarred stroma, metaplasia, ulceration, and irritated repair epithelium.

Glandular epithelium of the cervix is observed in changed and abnormal positions in conditions of dilatation from obstruction, with indwelling or contiguous infection, in hyperplasias, metaplasias and neoplastic new growths. The frequency of glandular erosion and retention cyst formation as sequelae of traumata and infection is impressive.

Stromal changes exhibit inflammatory processes in their various phases and sequelae. The stroma displays neoplastic advances. The time period of its use as a field of process activity is chiefly displayed in vascular fibroblastic and fibrocytic conditions.

The crux of histopathological work is reached in the study of cervical tissues when all processes are correlated in progressive chronic conditions that may lead to malignancy. Judgment and experience gained after perusal of the best in the literature and tested against the values learned by clinical controls, become more and more certain in diagnosis.

There is no other field where malignancy can be so advantageously studied as in the cervix, affording as it does:

- a. Accessibility.
- b. Frequency of occurrence.
- c. Localization.

d. Specific association in perhaps 100 per cent of occurrences with trauma, infection and continued irritation and 90 to 98 per cent with childbearing.

e. Age of lesion incidence (not the age of patient necessarily).

f. Availability of biopsy tissue before, during and after treatment.

g. Accumulation of large files of tissue sections.

The material in this series of 1200 cervices contained stratified epithelium in 947 cases, glandular epithelium in 900 cases, and stroma in 1200 cases.

Inflammatory reactions were observed in 777 different tissues. Of these, one only was tuberculous, and 8 were syphilitic. Degenerative changes were present in 725 different sections. Benign new growths were present in 35 cases, polypoid hyperplasias in 16 cases. Evidence of pregnancy was present in 15 cases. Malignant neoplasms occurred in 185 cases. Of these, 170 were epidermoid carcinomas, 12 were adenocarcinomas, and 3 were sarcomas. Metastatic carcinoma from the rectum occurred once. Procidencia was observed in 26 cases.

In one's search for malignancy the stratified epithelial behavior is of first importance. The most unstable epithelium is that which is most immature. This immature epithelium is destined to complete differentiation and to mature the cell units in size, resistance, form and function. The producing or genetic cells are those of the basal line. The young immature cells produced are just above the basal line and make up the intermediate zone. The surface or scale-like cells are ripened units containing some amount of keratin.

The embryonic stratified epithelium of the cervix has apparently no natural liability to malignancy. Cervices that are not lacerated or infected, rarely, if ever, become malignant. The constant appearance of the area of malignancy exhibiting injury, irritation, infection, derangement of cells and undue growth stimulation, is convincingly evident. These influences when continued over a long enough period from the basal side of the layer, affect the embryonic cells in such a way as to prevent their differentiation and maturation going much beyond the stage where only the ability to reproduce is reached.

TABLE I
HISTOPATHOLOGY IN 1200 CERVICES

	Cases
<i>Tissue histology:</i>	
Stratified epithelium.....	947
Glandular epithelium.....	900
Stroma.....	1200
<i>Pathology:</i>	
<i>Inflammation:</i>	777
Purulent.....	18
Luetic.....	8
Tuberculous.....	1
Abscess.....	1
<i>Degeneration:</i>	725
Laceration.....	725
Erosion.....	721
Retention cysts.....	367
Fibrosis (stromal).....	340
Fibrosis (vascular).....	267
Fibrosis (grade 1).....	12
Fibrosis (grade 2).....	99
Fibrosis (grade 3).....	139
Fibrosis (grade 4).....	16
Epithelial repair.....	287
Ectropion and cornification.....	200
Ulceration.....	86
Thrombosis.....	5
Calcification.....	3
<i>Neoplasia (benign):</i>	34
Fibroma.....	1
Myomata.....	7
Polyps.....	26
(Polypoid hyperplasia).....	16
Endothelioma.....	1
<i>Neoplasia (malignant):</i>	186
Epidermoid carcinoma.....	162
Adenocarcinoma.....	12
Papillary carcinoma.....	8
Metastatic carcinoma (from rectum).....	1
Sarcoma.....	3
<i>Stage of maturity:</i>	
Unripe.....	71
Midripe.....	61
Ripe.....	39
<i>Radio-sensitivity:</i>	
Grade 1.....	38
Grade 2.....	61
Grade 3.....	43
(Less than one).....	22
<i>Addenda:</i>	
Procidencia.....	26
Decidual cell infiltration.....	15

When denudation of the stratified layer has occurred and the ultimate repair phase of production has been accomplished, it makes a great difference whether this epithelium is the first or later generation of repair cells. The youngest cells are least tolerant and succumb easily to neoplastic changes. A layer of this repair epithelium usually has but few, if any, scale cells

with hyalin and keratin present. The middle layer is made up of hyperchromatic, incompletely developed cells that have been contacted by the inflammatory cells and products over a long period of time. The effect upon these immature cells is overstimulation, resulting in rapid multiplication, accomplishing only the function of reproduction.

The basal cells become irregular in position and form and produce cells of different sizes and staining characteristics. The cell individuality is greatly changed, nuclear division being sometimes seen.

Malignancy occurs in ulcers of long duration at the stage when proliferation is active. There has been re-stimulation of the tissue by irritants. The proliferating downgrowths become involved with loss of the basal cells and exposure of the embryonic cells to the irritating inflammatory products.

The cervical glands are very resistant to injury and cell change occurs only as a response to the prolonged and virulent form of irritation.

It is in metaplasia, gland production, and irritation, and seldom otherwise, that malignancy occurs in these glands.

CLINICAL DATA

(A Cross Section of 150 Cases, Hospital A)

1. The cases of cervicitis and endocervicitis without a single exception gave evidence of some degree of laceration.

2. The chief complaints recorded for this group were as follows:

	Per Cent
Pain in the lower abdomen.....	48
Leucorrhea.....	32
Pain in the back.....	16
Irregular menstruation.....	12
Dragging sensation in the pelvis....	12
Fainting spells.....	8

3. The symptoms in group 2 in many instances were variously associated and in other instances a single symptom prevailed as a subdominant complaint in a higher

percentage of the patients. Leucorrhea, for example, prevailed in 88 per cent of all cases through variable periods of time that always dated back to the last childbirth. Twenty-eight per cent of all the patients complained of dragging sensation in the pelvis but did not give this symptom first importance. In the 12 per cent listing this symptom first, there was usually a retroverted position of the uterus.

In the group giving pain in the back as the most important symptom, all had a history of severe laceration following hard long labors in which instrumentation had been used in many instances.

In 28 per cent of the cases having had hard labors and lacerations of varying degrees, there were sequelae of irregular menstruation. In a number of cases severe dysmenorrhea occurred with prolonged and profuse bleeding lasting seven to nine days. In others there was suppressed menstruation once in two to three months.

When headache occurred, as it did in 4 per cent of the cases, it was severe and of occipital or frontal type. It usually came on in the morning and lasted from one to four hours.

Hemorrhage occurred as a sole chief complaint in 8 per cent of this series. Twenty per cent, however, listed hemorrhage as a symptom with which was associated excessive flow during and after menstruation. As a sequel there followed secondary anemia of variable severity and duration.

In 12 per cent of the 150 cases with malposition of the uterus, there existed deep cervical tears in the vaginal vault.

(A Cross Section of 639 Cases, Hospitals B and C):

From hospital B, 62 consecutive clinical records with accompanying reports of tissue diagnosis were studied and combined with 377 similarly completed records from hospital C.

The analyses included age incidence, marital state, pregnancies, cardinal symptoms, and variations in menstruation.

Age Incidence:

Years	Cases
Under 20	3
20 to 30	125
30 to 40	188
40 to 50	77
50 to 60	35
60 to 70	9
Over 70	2

Marital State and Number of Pregnancies:

	Cases	Per Cent
Nullipara	57	12.2
Married and childless	39	8.8
One child or one miscarriage	59	13.4
Two or more children	274	63.3

Of the entire group of 439 patients 31 were colored, 408 were white. Forty-six of the patients were Jewish.

Menstrual Disorders: Fifty-eight per cent of the series gave menstrual disorders as chief complaints. Of this group menorrhagia occurred in 12 per cent and metrorrhagia in 24 per cent.

Leucorrhea: Forty-nine and six-tenths per cent or 218 of the group complained of leucorrheal discharge.

Pain: Fifty per cent of the patients complained of abdominal pain; 32 per cent described the pain as associated with a bearing-down feeling in the lower abdomen.

Backache: This symptom was present in 28 per cent of the patients. Fully 25 per cent gave a history of this complaint existing since the last pregnancy.

Cervical Pathology:

Cervicitis was evident	in 414 cases (or 96 per cent)
Laceration and erosion	in 213 cases (or 49 per cent)
Prolapse	in 37 cases
Polyps	in 29 cases
Carcinoma	in 25 cases (or 5.7 per cent)

Three of these cancers were in nullipara. Eighty-eight per cent occurred in women who had been pregnant. Three were in colored women and one in a Jewish woman (1 in 46, or 2.17 per cent). There were no carcinomas in the prolapsed uteri.

Operations were performed as follows:

Dilatation and curettage	151
Sturmdorf's operation	119
Trachelorrhaphy	105
Amputation of cervix	39
Biopsy section	47
Hysterectomy	62

Summary of Clinical Data:

In 589 cases from hospitals A, B and C:

	Per Cent
Pain in the lower abdomen occurred as a chief symptom	49.0
Leucorrhea	41.6
Menstrual disorders	35.0
Pain in the back (since last childbirth)	22.0

Groupings of these main symptoms occurred frequently. Each of the foregoing symptoms occurred in higher percentages when recorded not as dominant but as occasional or associated subdominant complaints. For example, leucorrhea is previously mentioned as having prevailed in 88 per cent of all cases.

TREATMENT

Treatment of cervical pathology has possibilities for success not equaled elsewhere in the body. There is most convincing evidence given by many operators and writers that repair of injuries in the cervix can be done immediately so as to prevent almost all erosions, ulcerations, ectropions and infections.

With repair accomplished and the foregoing changes prevented or cured, there is but little chance, perhaps not more than one in 5000, that malignancy will ever develop. The results accomplished by correct repair appear so certain that even the percentage of cases assigned by inheritance to die do not even develop cancer. If all cervices of patients attended by the medical profession were properly repaired, cancer of the cervix mortality would receive a forced reduction of over 90 per cent.

In the group here studied, 1015 were free from carcinoma, yet approximately 10 per cent or more than 100 gave clinical, gross and microscopical evidence of tendencies

towards malignancy. If prevention can be expected to save 95 to 100 per cent of these cases, what greater field of endeavor is there open in the practice of medicine.

In 3500 sections examined, there were very few tissues removed needlessly. If only the same zeal prevailed for removal of pathological cervical tissues as is practiced upon appendices and tonsils, a most remarkable reduction would follow in the rate of cervical carcinomata.

Our distinguished guest, Professor Adler, of Vienna, has ably presented the successes and failures attained by heroic means of treatment that are limited both in choice of operable cases and in operators of experienced capability.

The workers with x-rays and radium have a larger field in case selections and are able to report a better salvage of advanced cases.

With surgery or irradiation uncombined or combined, "80 per cent of all cases seen will fail to survive five years."

The type of pathology under discussion in this paper is highly segregated by the history of pregnancy. The events of pregnancy quite generally permit unhindered prepuerperal and puerperal treatment for infection and repair providing 95 to 100 per cent prevention of cervical carcinoma over (not a five year period) a life time.

SUMMARY

1. Histopathological studies were made of approximately 3500 sections of 1200 cases from which biopsies were obtained, the material having been selected after certain clinical indications.

2. All sections received a diagnosis following their removal, and certain "follow-up" data have been available.

3. The second review of sections was independent of the first diagnostic work and was completed as a consecutive study following a survey of the literature covering the past six years.

4. Approximately one-third of the biopsy tissue from this series was of little value because of improperly taken sections that

omitted stratified epithelium and glandular epithelium. An imaginary hemisected plane should be made of each cervix, and the most fertile pathological half is selected for a section 1.5 cm. long, the upper portion of which is 0.5 cm. within the external os. The tissue selected should present abnormal characteristics to both ocular and palpatory examinations.

5. The examination of a large number of tissues and case histories in sequence afforded standardization values not otherwise obtainable. In this series 186 malignancies occurred and all gradations of tendencies from the normal tissue structure to that of malignancy were observed as oft-repeated pictures.

6. The exceptional opportunity provided by a large number of cervical tissues emphasizes certain very clearly defined principles associated with malignant changes. There is no evidence that mature normal tissues (as judged by the usual histopathological standards) can pass over into a state of malignancy.

7. There was abundant and convincing evidence in this material that the following conditions were essentials of the premalignant and malignant process:

(a) Tissue injury.

(b) Continued unremitting irritation to tissue layers and cells.

(c) Demobilization of tissue and cell relations.

(d) Exposure of immature, incompletely differentiated cells to continued irritation and hyperphysiological stimulation.

(e) Newly produced cells with cessation of maturing ability in form and function beyond that of simple division, and these cells in turn are of less mature appearance.

(f) The progeny of the basal cells in the stratified epithelium when exposed to chronic inflammatory effects delivered from the stromal side, displayed the most frequently produced pictures of the beginnings of malignancy.

8. The clinical symptoms of pain in the lower abdomen, leucorrhea, menstrual disorders and pain in the back prevailed in

from 49 to 22 per cent of the cases in the order named as dominant complaints.

9. Prevention of cervical pathology is a most profitable field of therapeutic endeavor. In cases of laceration, erosion, ectropion, infection, ulceration, early and adequate attention yields almost a perfect score of cures and at the same time prevents cancer formation in from 90 to 100 per cent of cases. The same attention given to the cervix that has been directed to the

appendix and the tonsils would secure an astounding change in the cancer statistics of the cervix.

10. The study of cancer is more favorably accomplished in the cervix uteri than in any other tissue of the body; irritating etiologic factors may be followed and tissue change observed at any stage before and during cancer formation. Effects of treatment can be safely studied in biopsied tissues.

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TUBERCULOSIS OF THE GENITOURINARY TRACT*

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IN choosing as a leading topic from the domain of the genitourinary system, tuberculosis of those organs, it is, I think, wise to have a paper upon such subject bear a comprehensive title, in order that it may open up an unrestricted discussion embracing the entire field. This is manifest because tuberculosis, not being solely a urological malady, but in point of fact a constitutional invasion, is and always has been extensively written about, intensively studied, given special classification in medical literature, in hospital practice and in municipal public health supervision. All this has tended toward standardization of our knowledge of the subject with the establishment of certain accepted facts which may not at this time bear modification. Thus it would be of doubtful value to consume more space than is necessary to recount some of these generally recognized truths and be of greater interest to invite contribution to the discussion of the still disputed questions. In order to attain this object the whole field must be included. It will be my purpose, therefore, to call attention to some of the moot points in the urological field of tuberculous invasion and to set forth, as well as may be, the pros and cons thereon.

For general consideration, tuberculosis of the genitourinary tract is divided into that of the urinary organs, on the one hand, which embrace the kidneys, ureters and bladder, and on the other, tuberculosis of the genital tract, consisting of the prostate, seminal vesicles and testicles. Tuberculosis of the kidney is by far the most common of these lesions, extension of the disease to the kidney being secondary to a primary focus, pulmonary or gastrointestinal; likewise, involvement of the other urinary and of the genital organs is usually, although

not essentially, secondary to that of the kidney.

I will first undertake to present what would seem to be today substantially agreed upon as some of the classical features of tuberculosis of the urinary tract: As to the prevalence of the disease in the urogenital tract, it is generally recognized and recorded that the decline in pulmonary tuberculosis in the last decade is anywhere from 20 to 25 per cent. Hence there is to be expected, and statistics indicate, a relative decrease in involvement of the genitourinary organs. This acceptable abatement in this scourge of civilization is a justification of modern methods of hygiene, and of the emphasis which has been laid on the need for sanitation, intensive diagnostic study, prophylaxis and better living conditions.

The importance of the urogenital tract in any consideration of regional tuberculosis is manifested by the demand for operations upon that tract, as for example, tuberculosis of the kidney. This is stated to comprise, as quoted by V. C. Hunt,¹ 27 per cent of all nephrectomies at the Mayo Clinic for surgical lesions of the kidney. This number represents about 0.5 per cent of all operations performed in a general hospital, and while not revealing the percentage of occurrence of involvement of the urinary organs in cases of pulmonary tuberculosis, it is stated by Kuster as cited by Caulk² that 10 per cent of patients dying of tuberculosis have kidney involvement.

A very important consideration in studying this subject is the frequency of bilateral renal involvement. This is of prime significance for it may, or may not, determine the question of the expediency of operation in a case where surgical intervention is palpably indicated.

* From the Department of Urology, French Hospital, New York. Submitted for publication January 6, 1932.

The percentage of bilateral involvement has been variously stated, according to individual experience, approximating 15 to 25 per cent as confirmed by clinical and other diagnostic data. The percentage would be highest when revealed through necropsies, not only because such fatal cases are on balance in a more chronic and advanced stage of the disease, but likewise because the complete investigation, embracing sectioning and cross-sectioning of both kidneys, lessens the chances of overlooking minor lesions. This subject will be further discussed when those questions that may be considered as still debatable and upon which there is not a general consensus of opinion are taken up.

Etiology. The etiology of tuberculosis of the genitourinary tract is indisputable, it being secondary to a pre-existent focus elsewhere, usually pulmonary. It is stated that renal tuberculosis is secondary to pulmonary in about 50 per cent of the cases. It would seem that the percentage of such derivation from the pulmonary tract is even greater than this, although the alimentary tract, the mesenteric and other lymph glands and the bones may have an intermediate connection therewith; the blood stream is the medium of communication and the tubercle bacilli the agents of transmission. The question as to whether these agents can enter the blood, then reach the kidneys and pass out of the organism without creating any disturbance in passing, is another subject of debate to be dwelt upon later. It suffices to say here that in some instances the kidney unquestionably becomes the site of tuberculous deposit early in the clinical history of a pulmonary subject; in others, the more chronic the disease, the more threatening it becomes to the genitourinary system, as it also is to other tissues of the body.

It is not necessary to dwell upon the contributing causative agencies in tuberculosis, such as bad hygiene, inherent predisposition or lack of resistance; to these must be added the local elements of causation that may be present in the organs

themselves. Of such elements may be mentioned, trauma, pre-existent invasion of other organisms, abnormal functioning efficiency.

Pathology. The pathology of urogenital tuberculosis in a broad sense may be stated as presenting itself anywhere from a miliary to a massive involvement, and ranging from an acute to a chronic development.

Clinical Picture. The clinical picture of urogenital tuberculosis naturally varies with its location. It is an outstanding fact that tuberculosis of the kidney may continue to an advanced stage before it is detected. This does not apply to acute kidney involvement of the multiple miliary abscess-foci variety, but to chronic tuberculosis of the kidney which progresses slowly, there being a continuous antagonism between the protective agencies of the body and the irritating tuberculous process, a process amounting often to an encapsulation and the establishment of silent encysted areas. These conditions may remain, producing little pain or other disturbance until a coalescence of other abscesses occurs with an extension into the renal pelvis. When the bladder and ureter are subjected to a continuous flow of tuberculous infected urine, there is usually exerted a strong resistance to infection; but the ureter may become a direct extension and a part of the kidney lesion. The bladder mucous membrane resists for a long time, usually becoming involved late in the disease only. Such involvement, revealed by frequency and irritability of urination, in many instances is the first manifestation to attract attention to the urological phase of the disease. Therefore, it may be a matter of years before clinical evidences of urogenital tuberculosis are detected. When the tuberculous process attacks the genital organs, the symptoms will assume a character peculiar to the region involved.

Diagnosis. The diagnosis of urinary tuberculosis is accomplished by a routine examination embracing the laboratory evidence supplied by functional urinary tests

aided by cystoscopy with ureteral catheterization and pyelography. This investigation should be repeated on different occasions until a final corroborated diagnosis has been reached. In the case of genital tuberculosis, the existence of tuberculosis in other parts of the organism provides a clue. The urinary tract should always be searched for other lesions. Rectal examination is relied upon to detect tuberculous involvement of the prostate and seminal vesicle and the discovery of a pathological infiltration of these organs in association with a tuberculous lesion elsewhere suggests the probable diagnosis.

Treatment. The treatment of *genital* tuberculosis when it is localized in the external genitals affords little for special discussion, being governed by general surgical practice, as applied to sinuses, abscess and the radical removal of the involved glandular organ. The question of the treatment of the internal genitals being debatable, is referred to a later section of this paper. The treatment of *urinary* tuberculosis may be summed up in general terms: Nephrectomy should always be resorted to as early as possible for an active tuberculous lesion confined to one kidney. This generally exercises an inhibiting effect upon bladder involvement not too advanced in character, varying in its time of alleviation from a few weeks to many months. In the case of active vesical ulceration or more prolonged inflammation, other local treatment is demanded, such as diathermy and, in advanced cases, fistulous surgery.

DEBATABLE QUESTIONS REGARDING UROLOGICAL TUBERCULOSIS

While the points concerning tuberculosis of the urogenital tract just enumerated are conceded by most students of the subject, there are a number of questions concerning which there is much difference of opinion. Such pronounced controversy on the part of authorities may well cause those less familiar with the subject great

difficulty in judging the merits of any particular case presented, but in many individual cases it is often possible to reconcile such divergent opinions.

The first question of a controversial nature to be considered is:

1. *Can the kidney secrete or excrete tubercle bacilli and itself remain healthy?* That is to say, do tubercle bacilli appear in the urine independent of a renal lesion? Does a healthy kidney excrete microorganisms or harbor them? This question might be answered by the statement that even if the healthy kidney excretes microorganisms of any character, the pathological kidney might harbor them and a previously nontuberculous pathogenic kidney would thus become a tuberculous organ. Wildbolz³ takes exception to the statement that the finding of tubercle bacilli in the urine is evidence of a caseous tuberculosis of the kidney. He holds that the presence of bacilli in the kidney secretion may be due to "tuberculous bacilluria" which is an excretory action on the part of the kidney seen in patients having pulmonary foci of an advanced nature. This might occur without there being any tuberculous changes in the kidney. In a word, Wildbolz makes the significant statement, which he thinks is indisputable, that tubercle bacilli may pass through the kidney and appear in the urine without demonstrable tuberculous tissue changes and without the presence of pus in the kidney secretion.

On the other hand, the contribution of Bumpus and Thompson⁴ in referring to records of the Mayo Clinic up to January, 1929 and stressing "changing conceptions" upon the subject treated "in the decade 1920 to 1930," reaches the conclusion that a normal kidney cannot filter bacteria out of the blood stream into the urine and that the presence of bacilli of tuberculosis in the urine almost always indicates renal involvement.

Medlar⁵ reached the same conclusion, viz., that tubercle bacilli are not secreted in the urine without tuberculous lesions being present in the kidney.

Caulk² takes issue with the suggestion made by some observers that tubercle bacilli are found in the kidney specimens independent of a renal lesion.

In reviewing this question, one must take the stand that the preponderance of evidence favors the view that tubercle bacilli in the urine indicate the presence of tuberculous lesions in the kidney excreting it. A so-called "tuberculous bacilluria" is believed to exist due to the excretion by the kidney of tubercle bacilli from the blood in patients free from symptoms, but there is not a sound basis for the belief. While the kidney might excrete toxins just as it does chemical agents, without the existence of a lesion, there is not sufficient basis for the claim that the organisms themselves are excreted without the existence of a kidney lesion. Therefore, we must subscribe to the concrete statement that the presence of tubercle bacilli in the urine is positive evidence that one or both kidneys are involved.

The second question upon which there has been controversy and difference among authorities, is: *Can a tuberculous kidney lesion heal spontaneously?*

This question, when put to him by the patient, calls for an answer from the medical practitioner. It is the belief of Harris of Toronto⁶ "that minute foci of tuberculosis in the kidney undergo healing just as do tubercles in other tissues." He further states "that there is the fact that early small lesions at least have a strong tendency to heal. The lesion may heal in this early stage so that the patient goes through the whole course of renal tuberculosis without ever presenting symptoms attracting attention to the genitourinary tract." On this point we might emphasize the fact already mentioned, that in the clinical history of renal tuberculosis, months and years may pass before its manifestations attract attention.

Chute⁷ thinks that tubercles are brought to the kidney in large numbers from foci located elsewhere but that the generous blood supply of the kidney enables it to

overcome most infections while they are still incipient. That the initial lesions of tuberculosis often heal is confirmed by Bumpus and Thompson⁴ in reporting their experience with 300 cases of genital tuberculosis.

Braasch⁸ of the Mayo Clinic states "we formerly believed that renal tuberculosis never heals spontaneously." Yet he believes that early renal infections of tuberculosis without necrosis or destruction of the kidney substance might permit a spontaneous healing.

Medlar⁵ in experimenting upon animals, found scars upon the kidneys which he took to be a "reparative process" and he states that this was confirmed by later experience with human subjects.

Those who hold the opposite view are equally positive that their position is correct.

Maurice Persson⁹ states "it has been impossible to demonstrate spontaneous healing of tuberculosis of the kidney in a single case."

Caulk² holds in a recent contribution that "the only way in which a kidney may apparently heal is through its seclusion by ureteral stricture with subsequent auto-nephrectomy and occasionally by localized isolation in certain portions of the kidney."

Wildbolz³ of Switzerland, much quoted authority, remarked "that if healing of a clinically demonstrable caseous renal tuberculosis ever occurs at all it is certainly extraordinarily rare."

Lowsley and Kirwin¹⁰ in their textbook state that in the early detection and extirpation of the tuberculous process of the kidney "lies the patient's only hope of cure."

On the other side of this question is a case related by Barney¹¹ of Boston, reliable and conservative observer. This patient was seen by him eight years previously when he diagnosed a right pyonephrosis for which a nephrectomy was refused. Ten months later abscesses formed and opened in the buttocks leaving sinuses. A year later cystoscopy revealed edema of the vesical

neck with pus and tubercle bacilli in the urine from each kidney. The right kidney function was very poor, the left below normal. Pyelograms of each side showed markedly dilated pelves and blunted calices. Under the circumstances of what seemed to be a bilateral involvement, it was not felt that operation of any kind was justifiable. The patient went to Maine, lived out of doors, gained 40 pounds in weight and eight years after the original examination, cystoscopy revealed a perfectly normal bladder and ureters, with normal urine coming in good time from both sides. The pyelogram showed some distortion but little that could be termed abnormal. This history was verified by careful laboratory studies and was reported as a case of healing of tuberculosis without operative interference of any kind.

In the face of this conflicting judgment on both sides of the question, what attitude are we then to assume? It is that truth and reason are to be found on both sides of the question. The rules that apply to a pathogenic process of any kind apply here. A mild process, tuberculous or otherwise, can, under favorable conditions, disappear spontaneously. A tuberculous process is less likely to do so than otherwise.

An abscess is a surgical lesion and as such demands surgical intervention. An organ *greatly* destroyed by a vicious process is better removed than allowed to remain to contaminate further the body organism.

How far a tuberculous process can advance and still undergo a reparative healing process it is impossible to state. We do know that the advantages derived from sunshine, from outdoor air and from good food and hygiene are almost in some instances beyond limits.

3. *In bilateral cases, should the more diseased kidney be operated upon?*

This is another much contested question. In all of the bilateral cases reviewed by Persson⁹ which were nephrectomized, the patients died within two years of operation. Nephrotomy and resection uniformly gave bad results. At the Mayo Clinic,¹² 18

cases of bilateral infection were operated upon over a period of nearly a quarter of a century. Of these, 4 patients died immediately after operation and 10 within eighteen months, most of them from renal insufficiency or from the effects of tuberculous processes elsewhere in the body.

Legueu¹³ reported 93 cases where a nephrectomy was performed despite the existence of bilateral infection. Of all these patients it was recorded that 13 died from anuria immediately after operation and 30 died during the succeeding three years, leaving hardly more than 5 per cent alive. Many of these were in an advanced stage of tuberculous infection.

Hunt of the Mayo Clinic says:¹ "Nephrectomy in the presence of bilateral renal tuberculosis is seldom indicated or justifiable." He qualifies this, however, by adding that it may occasionally be justly considered if there is much pain, hematuria or acute sepsis in one kidney, and only slight involvement in the other. Wildbolz believes that tuberculosis of the kidney is often diagnosed, when actually it is only the ureter which is involved. If one kidney is proved tuberculous and on the opposite side there are organisms in the ureter which have reached there by bladder reflux, and by proper catheterization the kidney can be proved sound, then the affected kidney should be taken out. "If the remaining kidney is also involved as well as its ureter, nephrectomy on the opposite side is not advisable." The suggestion which has attained considerable popularity of late, that is, that the more damaged kidney should be removed, provided the second kidney has fairly good function, this authority rejects with emphasis. He is positive that healing will never take place spontaneously in a kidney once actually invaded by the tuberculous process, and nephrectomy on one side merely shortens the patient's life.

Kretschmer,¹⁴ on the other hand, said of the 19.3 per cent of his patients who were proved to have bilateral renal tuberculosis that nephrectomy was "the only therapeutic agent at hand" for their relief. Yet

in his published writings he does not often mention having actually operated upon the more diseased organ in bilateral renal tuberculosis. Caulk says that removal of the more diseased of a pair of tuberculous kidneys is "not advisable."

It is not possible in my judgment to lay down a hard and fast rule upon this question; each case must be governed according to its individual peculiarities.

4. *What is the bladder picture in renal tuberculosis?*

There is much difference of opinion as to the condition of the bladder in renal tuberculosis, though at present quite general agreement prevails that the disease is seldom, if ever, primary to the vesical cavity.

Young¹⁵ says positively that the milder degrees of tuberculous cystitis are not of "characteristic appearance." He mentions especially, however, the tendency of inflammation and later, of ulceration, to center about the base of the bladder and the trigone. Even in unilateral renal tuberculosis the bladder lesions may be observed about both ureteral orifices. He mentions that the tags of mucosa and polypoid masses of granulation tissue seen about the ureteral openings in the later stages of kidney infection, often suggest malignancy, and cannot always be diagnosed with accuracy. But in the resumé of diagnostic measures for establishing the existence of renal tuberculosis, which he gives in his "Urology," Young lays very little stress upon the bladder picture.

Braasch and Scholl¹⁶ also mention the possibility of confusing the lesions about the orifice giving access to the infected kidney with vesical neoplasm. In many instances they have seen proliferation of the inflammatory area all across the trigone and even invading the farther portions of the bladder wall. It is apparent that they do not regard the cystoscopic evidence to be valuable unless corroborated by other data.

In contradistinction to this uncertainty in regard to the bladder picture we have

the very positive statement of Caulk² that "the cystoscopic picture of the bladder is the most definite single finding of urinary tract tuberculosis." He claims that by cystoscopy alone 78 per cent of his renal tuberculosis cases were positively recognized, although many other diagnostic procedures were used as confirmative measures.

I believe that a bladder picture may, and often does, afford *prima facie* evidence of tuberculosis elsewhere in the upper urinary or genital tract; yet corroboration should always be sought for and by persistence will almost always be revealed.

5. *Should genital tuberculosis (referring to the internal organs) be operated upon, and if so, what procedure is to be preferred?*

Ever since Young put forward his radical operation for genital tuberculosis there has been much discussion as to the wisdom of subjecting patients to so mutilating a procedure for the relatively small chance of life and health the operation may afford.

Bumpus and Thompson⁴ of the Mayo Clinic do not appear to advocate radical surgical procedures, and the same conservatism is evident in the writings of other workers in this clinic.

Much of the literature on the subject is in favor of the radical treatment because the majority of writers holding opposite opinions are silent inasmuch as they occupy the entrenched position of having nothing better to offer, surgically speaking.

It would seem, to *sum up* the question of treatment of general genital tuberculosis, that if it is possible to obtain hygienic surroundings and out of door treatment, heliotherapy, etc., this is the appropriate course to follow in conjunction with such surgical intervention as the activity of an existing localized process may demand. But as stated by Hinman¹⁷ this will also depend somewhat upon the economic situation of the patient and if such conservative course is economically impossible, resort to radical surgery may be the alternative.

I will close this urological contribution with the brief comment upon the general

topic that the result of the humane campaign against tuberculosis is a chronicle of splendid achievement in modern medicine. The credit is due more to the internists than to the specialists in this department, the urologist being only an accessory. The

fact which is of most consequence to the branch of the subject to which this paper is devoted is that with the great diminution of general and pulmonary tuberculosis comes also a relative conquest of the disease in its invasion of the urogenital tract.

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LIPIODOL INJECTION OF BILIARY FISTULAE

WITH REPORT OF A CASE OF A FOREIGN BODY IN THE GALL BLADDER FOR A PERIOD OF EIGHTEEN YEARS*

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INJECTION of biliary fistulae with radiopaque substances is of particular interest because by this method we are

Injection of the fistulous tract with a radiopaque substance will ordinarily make the solution of this problem simple. A much more direct attack may then be made upon the seat of the trouble by the surgeon.

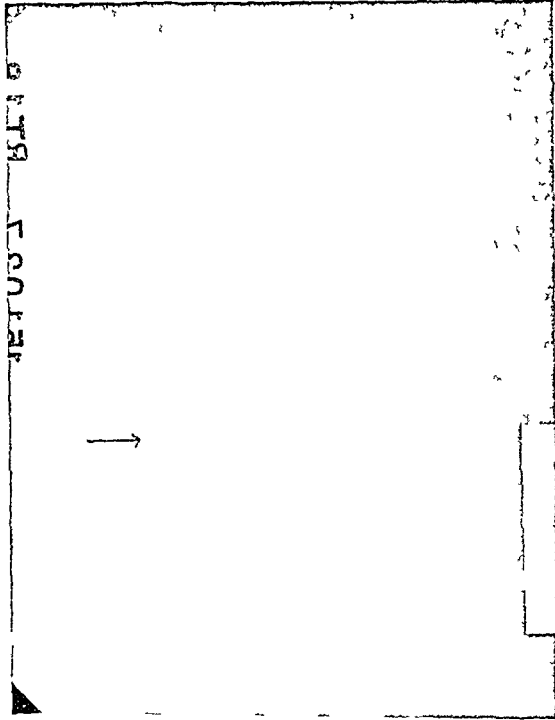


FIG. 1. Cholecystogram of Case 1. A faint outline of gall bladder against liver border is shown.

able to visualize the anatomy of the biliary passages in the living human. This is the only practical method we have of studying their anatomy and their pathological processes except by direct examination at the time of the operation. Even this does not show their anatomy in the full detail demonstrated by roentgenograms following the injection of radiopaque substances.

Determining the cause of the persistence of certain biliary fistulae and finding the location of the obstruction often presents a most difficult problem to the surgeon.

LITERATURE

Visualization of the gall bladder and biliary passages by the injection of radiopaque substances through biliary fistulae has been used rather widely for the past several years to determine the cause of the persistence of these fistulae. Lanari and Squirru¹ in 1924 showed roentgenographs of the biliary passages after lipiodol injections.

Cotte² in 1925 demonstrated very clearly the presence of a calculus in the ampulla of Vater by lipiodol injection of a biliary fistula. Gauillard³ and Ronneaux⁴ in 1927 each reported a case of closure of the common duct after cholecystectomy which was relieved by lipiodol injection.

Frazier⁵ in 1929 reported the results of experimental work with campiodol (iodized rapeseed oil) as a radiopaque substance. The injection of this material into the biliary passages of one dog gave good visualization and no apparent bad results. This same liquid was used by Overholt⁶ for testing the patency or cause of obstruction of the ampulla of Vater by injection through the r-tube inserted into the common duct at the time of operation.

Caeiro,⁷ Piccinino and Pazienza,⁸ and Ginzburg and Benjamin⁹ have reported postoperative studies of the biliary passages. The demonstration in the papers of Cotte,¹⁰ Overholt,⁶ and Ginzburg and Benjamin⁹ of these passages and of calculi in them is really remarkable.

* Presented before the West End Medical Society, February 28, 1931.

Mallet-Guy, Beaupère and Armanet¹¹ report the only complication found in the literature. A few hours after injection the

fistulae other than that given here. In 2 cases intermittent or partial obstruction of the cystic duct was the cause of the

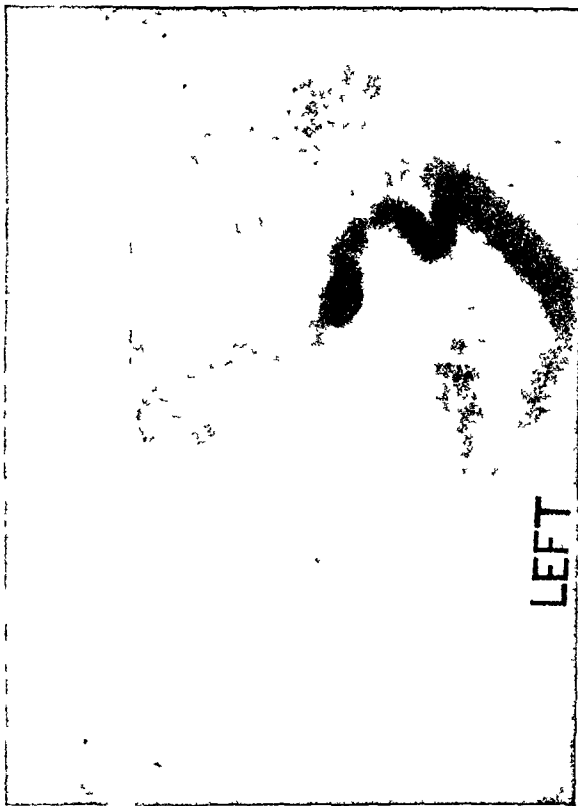


FIG. 2. Roentgenogram of Case 1 after lipiodol injection of sinus. The end of the catheter is in the sinus opening. The gall bladder with filling defect, the biliary ducts and some lipiodol in the duodenum can be seen.

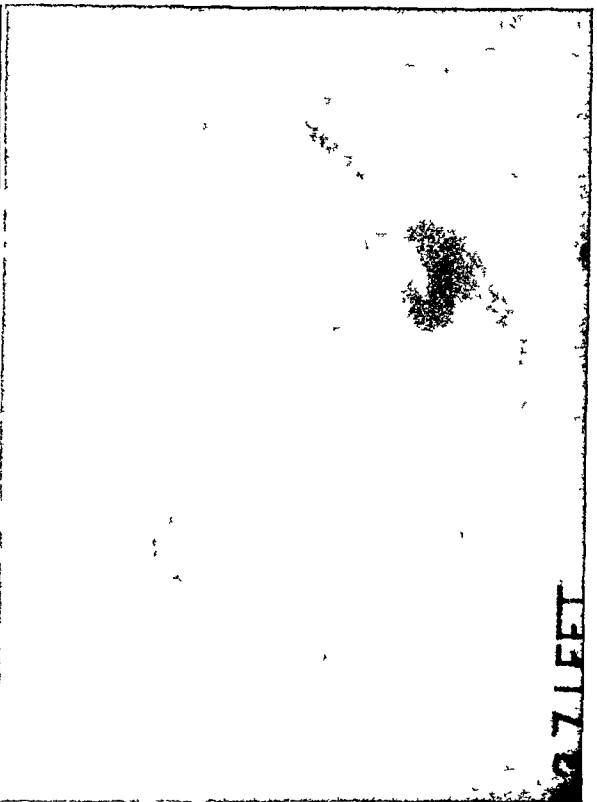


FIG. 3. Taken after Fig. 2 (Case 1). The catheter has been withdrawn. The branching of the hepatic duct shows.

patient had abdominal pain, colic, nausea and some shock. However, in this case it was necessary to inject a large amount of the lipiodol under considerable pressure in order to obtain visualization. Overholt⁶ reported one reaction of pain, nausea and vomiting. He attributed this not to the campiodol, but to the fact that a clamp had been left for some time on the T-tube with a blocked ampulla of Vater.

A review of the literature on the subject reveals that the commonest cause of persistence of biliary fistulae is obstruction of the common duct and ampulla of Vater. Although the following cases are reported primarily because they show the value of the lipiodol injection of biliary fistulae as an aid in the diagnosis of their cause, they also demonstrate two causes of biliary

fistula and in the other, a foreign body which had been present in the gall bladder for eighteen years without symptoms other than the fistula and that only for the last three years of this period.

CASE REPORTS

CASE 1. Mrs. S. F., a housewife, aged fifty, entered St. Luke's Hospital, October 20, 1930, because of a draining abdominal fistula. Eighteen years previously a cholecystostomy had been done because of cholelithiasis. Eight months later the opening closed and remained closed for fourteen years. For the three years preceding admission it had drained mucus or a green fluid constantly. At times the drainage had been profuse but without pain, nausea or other symptoms. At no time during this period had she lost weight or strength.

Physical Examination: The only abnormal finding was a draining biliary fistula in the center of a scar in the right upper quadrant.

lateral to the rectus muscle and its sheath. In the center of this was a small fistulous tract discharging bile-stained purulent mate-



FIG. 4. Pathological specimen from Case 1. The gall bladder has been opened. The tissue above is the excised sinus tract and surrounding scar tissue. The tape is shown in the position it held originally in the gall bladder.

When this was injected with lipiodol (Figs. 2 and 3), the biliary passages outlined well and the lipiodol passed readily into the duodenum. A large irregular filling defect showed in the gall bladder. A cholecystogram showed only a very indistinct outline of the gall bladder (Fig. 1). A diagnosis of very irregular calculus in the gall bladder was made from the roentgenograms.

Operation was performed on October 25, 1930, under ether anesthesia.

Pathological Findings: There was a healed scar in the wall of the right upper abdomen



FIG. 5. Case 11 after lipiodol injection. The sinus tract and the gall bladder show. The biliary ducts do not fill, which suggests an obstruction of the cystic duct.

rial. This tract was found to lead into the gall bladder at the top of the fundus where it was adherent to the abdominal wall. The gall bladder was about twice the normal size, grayish blue in color, its walls markedly thickened and the mucosa hypertrophied. A large irregular calculus could be palpated in the gall bladder. Dense fibrous adhesions bound the gall bladder down in its bed in the liver and to all adjacent structures. The cystic and common ducts, the ampulla of Vater and the head of the pancreas were normal to palpation.

Operative Procedure: A fusiform incision was made about the old scar and the skin edges about the fistula inverted with two rows of black silk sutures. The entire scar was excised en masse from the abdominal wall. After the adhesions were freed by sharp dissection the gall bladder was removed in the routine manner. All raw surfaces were peritonized and the abdominal wall closed in

layers with a rubber dam drain placed down to the foramen of Winslow.

Pathological Report by Dr. L. C. Knox:

Macroscopical Examination: The specimen consists of a gall bladder with a sinus tract leading through an area of dense fibrous tissue and fat to the skin surface of the anterior abdominal wall. The gall bladder measures 13 by 9 by 4 cm. and is surrounded by dense fibrous adhesions and fat. Its wall measures 0.7 cm. in thickness. The mucosa shows marked ulceration with hypertrophic changes in the central portion where a tightly rolled piece of gauze measuring 6 by 2.5 by 1.5 cm. lies (Fig. 4).

Microscopic Examination: Sections of the wall of the gall bladder show a chronic productive and exudative inflammation with marked thickening of the coats and fairly good preservation of the epithelium. There are large numbers of eosinophiles as well as lymphocytes and plasma cells in the mucosa. The muscle coat is hypertrophic and invaded by old scar tissue. Outside of the muscle is also a dense mass of fibrous tissue. The arteries are much thickened by a chronic productive endarteritis.

Diagnosis: Chronic productive cholecystitis with sinus tract.

Convalescence was uneventful. A very firm scar resulted with no sinus or fistula. Up to the time when last seen in May, 1931, she had had no symptoms of any kind.

CASE II. Mrs. M. McD., a housewife, aged forty-six, entered St. Luke's Hospital, September 27, 1930, because of severe abdominal pain with nausea and vomiting of two days' duration. She gave a history of previous milder attacks of pain in the right upper quadrant. Examination revealed an acutely ill white woman suffering severe pain. The abdomen was distended and generally tender and rigid, the rigidity most marked in the right upper abdomen. The rectal temperature was 103°F. and the white blood count 28,000 with 94 per cent polymorphonuclear leucocytes and 6 per cent lymphocytes. A diagnosis of acute cholecystitis and pancreatitis was made and operation done at once under ether anesthesia.

The peritoneal cavity contained a considerable amount of "beef-juice" fluid, although no areas of fat necrosis were noted. The gall bladder was about three times the normal size and acutely inflamed. The pancreas

was thickened and hard. Since the patient was extremely ill no attempt was made to do more than a cholecystostomy and insert two

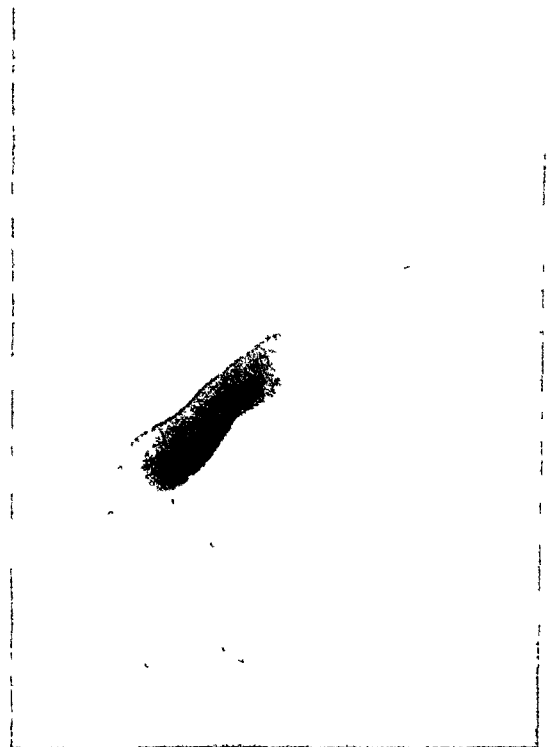


FIG. 6. Lateral view of Case II. Note the cone-shaped filling defect in the lipiodol at the beginning of the cystic duct. Attempt to do a cholecystogram showed no dye in the gall bladder.

rubber dam drains, one into the lesser omental cavity and the other into the right lumbar gutter.

After the operation the patient improved rapidly and was able to leave the hospital on October 28, 1930, with a fistula draining a small amount of mucus and bile. She was given two months in which to recuperate before the second operation. During this entire time the fistula drained mucus and pus and at times some bile. She had a continuous pain beneath the right costal margin associated with backache and pain in the right shoulder.

On December 30, 1930, she reentered the hospital. The gall bladder did not fill when an attempt was made to do a cholecystogram. Lipiodol injection of the fistula (Figs. 5 and 6) showed that it connected with the gall bladder. The lipiodol did not pass from the gall bladder into the biliary passages. The lateral view showed a filling defect shaped like an inverted cone at the ampulla which was interpreted

as being caused by a stone blocking the entrance to the cystic duct.

On January 3, 1931, under ether anesthesia

right lower quadrant. Five weeks before admission he had had a severe attack of generalized abdominal pain associated with

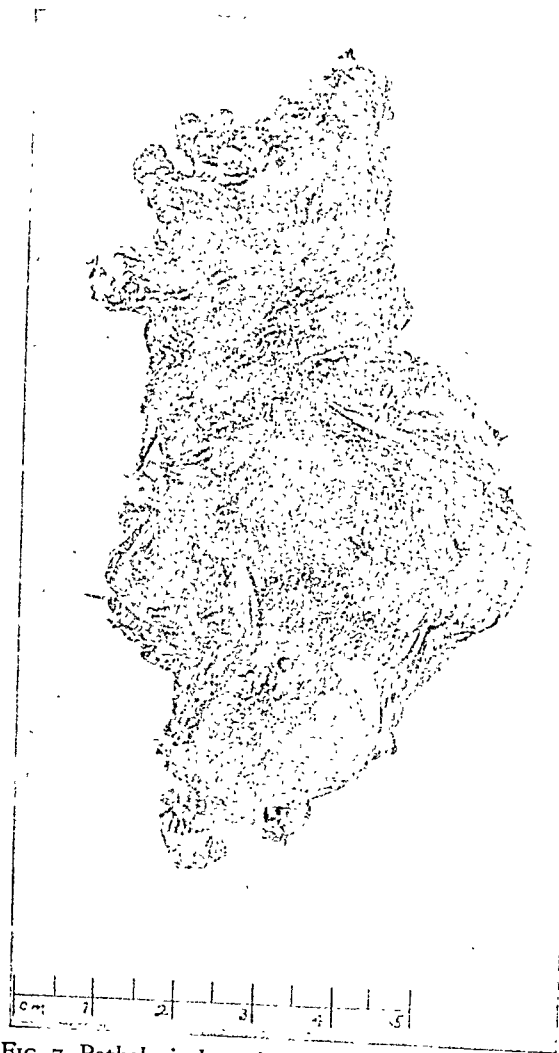


FIG. 7. Pathological specimen from Case II. The tissue above is the excised sinus tract and surrounding scar tissue. The stone is shown in the position it originally held in the ampulla of the gall bladder and corresponds to the filling defect in Fig. 6. The opening of the fistula can be seen in the fundus of the gall bladder.

the fistulous tract and the gall bladder were removed. The specimen with the stone in situ in the ampulla of the gall bladder is shown in Figure 7. She made an uneventful recovery and up to the time when last seen in May, 1931, had had no symptoms of any kind. The scar was firm with no sinus or fistula present.

CASE III. F. P., a negro porter, aged sixty-five, entered St. Luke's Hospital, September 3, 1930, because of severe pain in the



FIG. 8. Roentgenogram of Case III after lipiodol was injected into the fistula opening in the scar of the McBurney's incision. The tract leads into the gall bladder but the cystic and common ducts do not fill. The gall bladder showed no dye when an attempt was made to do a cholecystogram.

nausea and vomiting. From that time he had intermittent attacks of pain across the lower abdomen. On the day of admission he again had a severe attack of generalized abdominal pain which localized in the right lower quadrant. Associated with this were severe nausea and vomiting.

His temperature was 101.6°F., pulse 96, and respirations 22. The blood count was: White blood cells 28,000, polymorphonuclear leucocytes 88 and lymphocytes 12 per cent. The urine was negative.

Examination was that of a fairly well nourished elderly negro man who appeared acutely ill. The right lower quadrant was exquisitely tender to pressure and an orange-sized mass could be felt beneath McBurney's point. A diagnosis was made of appendicitis with perforation and abscess formation. Operation was done at once under ether anesthesia.

The abdomen was opened through a McBurney incision and an abscess containing about 8 or 10 oz. of thick pus was found about the cecum. The appendix was involved only in that it made up a part of the abscess wall. Because of the patient's age no further exploration was done. The appendix was removed and the wound closed with a soft rubber dam drain to the abscess cavity. At this time several small black granules were noted on the gauze packs which had been used. They had a somewhat crystalline appearance.

The postoperative diagnosis was abdominal abscess probably arising from an undiscovered perforation in the cecum or ascending colon.

Convalescence was quite uneventful. Purulent drainage was profuse for the first three days when it became very definitely bile-stained. A small amount of this same material continued to drain up to May, 1931. Lipiodol injection of the fistula (Fig. 8) showed that it communicated with the gall bladder but no lipiodol showed in the biliary passages or duodenum. The gall bladder was not visualized when an attempt was made to do a cholecystogram. These findings indicated an intermittent or partial obstruction of the ampulla or cystic duct.

Evidently this patient had had an acute attack of cholecystitis with perforation. As he was up and about a part of the time, an abscess formed in the region of the cecum due to gravity. The fine crystalline particles found in the contents of the abscess were undoubtedly small gallstones.

When the patient was seen in June, 1931, the fistula had been completely closed for two weeks and he had had no symptoms of any kind. Because of this fact together with his age and poor physical condition, cholecystectomy has been deferred indefinitely but will be done should he begin to have trouble.

DISCUSSION

The preservation of the structure of the gauze in the first case was really quite remarkable. It was stained yellow and felt stony although the roentgenograms failed to demonstrate the presence of calcium salts. No evidence of carcinomatous change could be found notwithstanding the eighteen years of chronic irritation.

The absence of pain or other symptoms was not surprising in that drainage either

through the cystic duct or the sinus tract was evidently at all times adequate. The presence of a large gallstone may be asymptomatic in the absence of infection, blocking of a duct or movement of the stone.

The opening of the sinus tract after remaining closed for fourteen years was possibly caused by the ampulla or cystic duct becoming blocked temporarily with pus and mucus. At the time the patient came into the hospital there was sufficient space for the passage of bile and lipiodol beside the tape and through the cystic duct.

The length of the cystic duct as shown in the roentgenograms of Case 1 appears much greater than one would estimate the average length, although at the time of operation it appeared to be no longer than those routinely found.

These cases demonstrate two causes for the persistence of biliary fistula other than the more common cause: closure of the common duct or ampulla of Vater. One is the presence of a foreign body in the gall bladder and the other partial or intermittent closure of the cystic duct. The opening in the gall bladder was made at operation in 2 cases and the perforation was spontaneous in the other.

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[For remainder of References see p. 58.]

A SPECIFIC TECHNIQUE FOR THE TREATMENT OF ACUTE PERFORATED APPENDICITIS*

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IT is customary to subdivide cases of acute perforated appendicitis into three groups and to recommend somewhat different forms of treatment for each. Classified, the three types of the disease coming under this heading are as follows:

1. Perforation of the appendix with localized abscess formation.

In this connection the author does not believe it is of very great importance whether abscess formation occurs as a result of actual perforation of the appendix or whether infection of the periappendiceal tissue has taken place through the intact wall.

2. Diffuse spreading peritonitis.

3. Gangrene of the appendix.

In this contribution the author will not attempt to differentiate these three classes but purposes recommending a method of treatment which he believes has proved itself to possess advantages as compared with other methods commonly employed.

There is no need to stress, in this contribution, the importance of an early diagnosis or the necessity for instruction, of both the laity and the practitioners of medicine, with reference to the danger that may accompany the administration of a purgative to the patient suffering from appendicitis. The danger of the latter procedure and the imperative necessity of the former have been, so frequently and so vigorously, urged in numerous articles that it is believed a further reference to these aspects of the subject is unnecessary here.

The author is of the opinion that several doctrines with reference to the operative treatment of acute appendicitis deserve condemnation. In this respect the following are under consideration:

1. The teaching that the risk to the patient may sometimes be minimized by postponement of operation in the hope that a safe period may develop.

2. The teaching that it is a proper procedure to incise the abdomen, evacuate inflammatory material and to leave the removal of the appendix to a later date.

3. The statement that the peritoneal cavity cannot be drained and that in consequence it is useless or harmful to introduce foreign substances into the abdomen in the neighborhood of the appendiceal bed with this end in view.

4. The teaching that if drainage of the peritoneal cavity be not attempted there is less likelihood of a severe infection of the abdominal wall.

5. The employment of firm substances, such as rubber tubes or glass drains for the purpose of evacuation of secretions from the abdominal cavity.

6. The opinion, as exemplified in practice by many surgeons, that adequate exposure can only be obtained by the use of an incision through or alongside of the rectus muscle.

All surgeons will, I believe, agree that all cases of acute appendicitis, seen within the first twenty-four to thirty-six hours following the onset of the disease, require prompt or immediate treatment unless the attack is manifestly mild. Such immediate operation constitutes the most certain prophylactic in avoiding perforation.

In cases seen later than thirty-six hours after the onset of the disease it is usually possible to determine whether operation must be carried out immediately, that is to say with only such delay as is necessary for the exhibition of resuscitative measures

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such as the administration of subcutaneous salt solution and intravenous nutritive (glucose) salines, or whether operation may be properly postponed until a more convenient time, or until more adequate hospital facilities become available.

Although the author is not of the opinion that postponement of operation in cases of definitely walled-off abscesses is likely to improve the resistance of the patient to the infection and so diminish risks of operation, it is at the same time, I believe, reasonable to argue that hasty preparation and midnight operations in such cases may be harmful.

The author recently published an article¹ in which was recommended a definite technique which he believes has proved its value in the prevention of wound infection in cases of acute perforated appendicitis. In the former contribution, the consideration of the more general aspects of the treatment of acute perforated appendicitis was purposely omitted. In the article referred to, proof was offered that by the employment of the technique recommended, wound infection with consequent prolongation of active treatment and necrosis of the abdominal wall can be eliminated. Tables attached to the article referred to showed that not only does there appear to be a very definite shortening of hospital days when this technique is employed, but also that cases treated by the author's method appear to have exhibited a lessened mortality rate.

Since certain procedures appear to have demonstrated their value, both in so far as the mortality from the disease is concerned, and with reference to the shortening of morbidity as well as the avoidance of post-operative hernia, this further contribution is made. In all cases in which the diagnosis of acute appendicitis has been made, and a presumptive diagnosis of contamination of the abdominal cavity in the neighborhood of the appendix arrived at, the following technique is employed.

As a routine procedure, subcutaneous saline (Ringer's solution) is run into the

submammary regions during the period that the patient is in the operating room. In this way from 750 c.c. to 2 liters of fluid are introduced. As an anesthetic the author prefers nitrous oxide and oxygen, reinforced with novocaine nerve blocking and infiltration (recently avertin has been used with, I believe, favorable results), for all patients in whom it is believed that a risk of loss of life exists.

The vertical incision through, or alongside of, the rectus muscle is accompanied so frequently by untoward sequelae, that it should not, I believe, be employed in septic cases. At the same time the McBurney incision does not permit of sufficiently easy enlargement to make it useful in difficult cases. For years I have employed a modification of the incisions with which the names of G. G. Davis and Rockey are associated. The essential feature of this incision is that it cuts transversely the superficial tissues, splits in the direction of its fibers the aponeurosis of the external oblique, and enters the abdomen by splitting transversely both the anterior and posterior sheaths of the rectus muscle. The muscle itself is displaced toward the midline, care being taken to displace the vessels and nerves which are found upon the anterior surface of the posterior sheath of the rectus. If this incision be so placed that its medial border is approximately 2 to 3 cm. below the umbilicus and its lateral border 3 to 4 cm. above the anterior superior spine, it is a simple matter to enlarge the incision into the loin by splitting the two oblique muscles in the direction of their fibers. In this way an opening is obtained which will make it possible to deal with any complication in the neighborhood of the cecum and at the same time produces an incision which hardly requires suturing for its closure.

In order that infection of the abdominal wall may be prevented, the whole surface of the wound, following exposure of the peritoneum but prior to its incision, is dehydrated with alcohol, dried and bIPP rubbed into the surface.² In this way

subcutaneous tissue, fascial layers and the muscle surfaces are covered with a layer of liquid paraffin, bismuth and iodoform which will prevent contamination of the tissues by the infected material, which it is expected will be found when the abdomen is opened.

If the incision recommended be employed it will be found that the opening of the peritoneum through the posterior sheath of the rectus will almost invariably expose the caput of the cecum a few centimeters distal to its commencement. The author has made it a practice to pack off the small bowel from the neighborhood by means of small moist sponges. The cecum is then drawn up into the wound and the field visually and manually explored. If free fluid is discovered this is removed by means of suction and, in so far as possible, swabbing with sponges is avoided.

If, as is so frequently noted, in the type of case under consideration, the cecum cannot be drawn into the wound owing to fresh adhesions and edema of the mesentery, the index finger is employed to discover the line of cleavage which will permit exposure of the appendix or the periappendiceal abscess. As a rule no great force need be employed to open up the diseased area. At the same time the author is very firmly of the opinion that it is of the utmost necessity that the appendix be discovered and removed, at least in so far as its proximal portion is concerned. A suction apparatus must be available at the moment at which the exudate about the appendix is freed in order that diffuse soiling of the peritoneal cavity may be avoided.

Although unfortunately very late cases of generalized peritonitis with multiple walled-off foci of infection are still occasionally seen, the author is of the opinion that the most dangerous type of appendicitis is that of the gangrenous appendix situated in the medial side of the cecum, and so underlying the mesentery to the terminal ileum. In these cases extension of the anaerobic infection to the mesentery is prone to occur with the possibility, or

even likelihood, of thrombosis of the veins in the neighborhood.

A similar effect is produced, as has recently been noted by Deaver, when, with the appendix below or medial to the cecum, the engorged mesentery has become fixed not only to the appendix itself but has become constricted, and has possibly initiated gangrenous changes in the terminal ileum. The author has not personally employed the operation of entero-cecostomy as recommended by Deaver in such cases, but is of the opinion that in the unusual case which might prove fatal in consequence of obstruction, the procedure has much to recommend it. It may be pointed out, however, that with the technique recommended in this paper the area of most active disease is so easily opened up for investigation and, if judged advisable, the institution of a cecostomy or enterostomy carried out, that the addition of any plastic operation upon the bowel seems hardly called for.

As the author has already stressed, it is his opinion that the risk of life to the individual is increased if the appendix be not removed. Every effort must be made to discover the point of origin of the appendix on the surface of the cecum. This should be tied off and as much of the appendix as is recognizable removed. Since, in these cases, contamination of the intra-abdominal field has already taken place and the abdominal wall has been protected, it is not of the utmost importance that the appendix be removed in one piece; nor is it, perhaps, of prime importance that the distal extremity of the organ be identified. In as much as the cecal wall itself is usually edematous, in perforated cases, and consequently friable, it is, as a rule, inadvisable to attempt to bury the stump of the appendix. My experience has been that fecal fistulae do not develop in consequence of failure to carry out this procedure, since in no case during the five years under review has a fecal fistula been seen among the author's cases. For the actual removal of the appendix, particularly in retrocecal

cases, the surgeon must approach the task with considerable boldness. The technique named by Crile "the robin method," whereby the submucosa and mucosa are withdrawn from their confining wall, is sometimes of value.

The appendix having been removed and the stump ligated, the field of operation is cleansed by means of the suction apparatus and by gentle sponging. It is unusual to find that it has been necessary to invade the general peritoneal cavity to any considerable extent in order to carry out the necessary interference. Should bleeding be copious, it is advisable to pack the field with hot saline sponges for a few minutes in order to give an opportunity for blood coagulation in the torn vessels to take place. Since packing is to be resorted to in any event, it is not necessary to obtain complete hemostasis.

Whenever there is the slightest suspicion that necrotic material either has been left or may develop, that bleeding is likely to take place or, whenever it is to be expected that an exudate will be required on the part of the tissues to overcome infection, the author prefers to drain the cavity. For this purpose soft packing gauze, 2 in. in width, is employed. This is soaked in liquid paraffin and a small amount of bipp is rubbed on the surface of the gauze. The folded gauze is then packed down into the bed from which the appendix has been removed and withdrawn from the lateral border of the wound. The amount of fluid which pours out on to the dressings in even the most harmless appearing type of case, is sufficient, I believe, to convince the observer that less intoxication of the individual is likely to occur if an opportunity be given for the evacuation of this material, than if it be left to the tissues to bring about its absorption.

The examination of smears from the exudate obtained from the peritoneal cavity may form a reasonable basis upon which to rest a decision as to whether to drain or not; the author, however, is convinced

that all parties interested, nursing sister, hospital interne, attending surgeon and patient, will have a better night following operation if the rule be followed to drain all cases in which the slightest excuse for doing so is present.

In the more severe type of case, whether in consequence of diffusion of the general peritoneal involvement or the presence of a large area of edematous tissue, such as occurs in walled-off processes and more particularly in case of anaerobic infection of the tissues in the neighborhood of the gangrenous organ, it is the author's practice to place in the abdominal cavity a very large quantity of liquid paraffined gauze and as much bipp as is thought safe.*

The infected field, more especially the retrocecal tissues, the lower border of the caput and the right side of the pelvis, may be firmly packed with 2 in. or 4 in. gauze soaked in liquid paraffin and to which bipp is added. As a rule three or four large packs are introduced in this way in different directions. It is of the utmost importance that they should be firmly introduced into all interstices of the tissues. The doubled ends are then drawn into the wound and will be found to adequately close the opening in the abdominal wall. Two or three silkworm gut sutures should approximate the skin edges, more or less, in order that the packs may not be extruded. No sutures are introduced into the peritoneum, muscle or fascial layers.

The massive packs introduced into the severe types of cases are allowed to remain undisturbed for a period of from four to ten days, at the end of which time the patient is again anesthetised, the packs carefully removed and the field examined. When the retaining skin sutures are removed, the wound opened and the packs removed, the surface of the muscles, the peritoneum and the exposed bowel are found to be covered with firm, deep red granulations. If packing has been accurately carried out in the first place, no

* Not more, I believe, than a mass equal to approximately one dessertspoonful should be employed.

purulent material will be found present and only unusually small patches of necrotic material be found adherent to omental tissue or fascial edges.

Any sloughing material is removed, in so far as possible, without the use of cutting instruments and the abdominal wall closed in layers after the whole field has been carefully bipped following dehydration. If any considerable dead space appears to persist following the removal of the pack, or if further necrosis seems inevitable, a small liquid paraffin bipped gauze wick is again inserted.

prevents the development of interstitial tension, the sutures which approximate the skin edges and subcutaneous tissue should not be removed for twelve days following their introduction.

During a period of five years commencing during 1924, the author was in charge of the surgical service of the Western Division of the Montreal General Hospital. For the purpose of this contribution, the cases of acute appendicitis admitted to this hospital during four years, 1925 to 1928 inclusive, have been analyzed. During this period 471 patients having acute appendicitis

TABLE I
CASES OF ACUTE APPENDICITIS TREATED ON AUTHOR'S SERVICE

Total No. of Cases	Non-perforated	Deaths	Average Days in Hospital	Perforated	Deaths	Percentage Mortality Perforated Cases	Average Days in Hospital
248	170	0	11.95	78	3	3.84	17.02*

* Excluding fatal cases but including 1 case in hospital fifty days.

TABLE II
CASES OF ACUTE APPENDICITIS IN SECOND GROUP

Total No. of Cases	Non-perforated	Deaths	Average Days in Hospital	Perforated	Deaths	Percentage Mortality Perforated Cases	Average Days in Hospital
223	169	0	13.50	54	10	18.51	26.80*

* Excluding fatal cases.

The small pack or wick thus introduced is withdrawn at the end of seventy-two hours. A somewhat copious serous or seropurulent discharge may be poured out between the skin sutures. The latter should not, however, be removed on this account. Since at least one advantage of the mixture of liquid paraffin, bismuth and iodoform, which is known as bismuth iodoform paraffin paste (B.I.P.P.)⁴ is due to the fact that its presence over the surface of the tissues delays healing and so permits the evacuation of exudate from the depths of the tissues and consequently

were operated upon in the hospital. Of this number 248, or slightly more than half, were under his personal care or that of his associate, Dr. George D. Little. The patients in this group, Table I, were all treated by the technique referred to in this article. The patients in the second group, Table II, were all treated by surgeons of experience and constitute, I believe, an approximately similar variety of cases.

It will be noted that among cases in which perforation had not occurred prior to operation, the mortality was nil and

the number of hospital days approximately the same in the two groups, slightly under twelve days in the author's group and somewhat over thirteen in the second group. In the perforated cases the differences are, however, striking. In the author's group a mortality rate of less than 4 per cent was attained, whereas in the second group, the mortality rate was over 18 per cent. At the same time, the average days in hospital in the author's series was seventeen, whereas cases in the second group remained in hospital approximately a 50 per cent longer time, that is almost twenty-seven days.

In the author's own group of 78 cases of perforated appendicitis, all of which were treated in the manner recommended in this paper, no case of fecal fistula developed, and in no case was there evidence of spreading cellulitis of the abdominal wall or necrosis of fascia. The author has not seen a case of postoperative hernia or abdominal wall protrusion in any patient operated upon by him or his personal associates during the past ten years, nor has he had such an incident reported to him.

During the past ten years the author has employed a definite group of procedures in the postoperative treatment of all abdominal cases. This method has been altered only in individual cases in which the gravity of the patient's condition seemed to indicate the employment of more rigorous measures. There is an absolute prohibition of everything by mouth during the first twenty-four hours following operation. The patient (adult) receives, per rectum, immediately upon return from the operating room, one pint (20 oz.) of 1 per cent sodium bicarbonate in water. This dose is repeated three-hourly for four doses. Thereafter the patient receives, per rectum, 20 oz. of 2.5 per cent glucose in half normal salt solution every four hours. For thirst the patient receives 20 oz. of tap water, per rectum, as required. In the hot summer weather 6 or 8 pints of water are frequently administered in this way.

If the fluid is run into the rectum at such a rate that approximately twenty minutes are required for the introduction of 20 oz. it is unusual for the patient to be unable to retain the necessary amount. The usual explanation for the report being made that the patient is unable to retain the fluid is the necessity for an enema.

I have always allowed my patients to receive a sufficient amount of morphine or pantopon to ensure rest. As a rule no enema is employed in less than twenty-four hours from the time of operation. The relative absence of "gas pains" with such a technique is proof, I believe, that these pains are in fact due rather to peristaltic effort on the part of the irritated bowel than actually to the presence of gas in abnormal quantities.

During the second twenty-four hours following operation the patient is allowed, by mouth, water, ginger ale, orange and lemon juice, sweetened to taste with glucose, and not with cane sugar. If such a procedure has been followed, the usual less important type of case, such as simple appendectomy or herniotomy, is prepared for a solid diet after forty-eight hours. It is unusual, in my experience, to have vomiting exhibited, irrespective of what type of anesthesia has been employed.

Patients who are more gravely ill, such as many of the cases under discussion in this contribution, receive, in addition, intravenous glucose saline solutions, 5 or 10 per cent glucose in normal saline. As a rule, two or three doses of 750 c.c. each, in each twenty-four hour period, are so administered. The author has never been impressed with the value of stimulants, such as strychnine, camphor or caffeine. Patients who appear to be *in extremis* receive in their intravenous glucose solution from 8 to 15 minims of adrenalin. After the first twenty-four hours, if the patient's condition continues to appear dangerously grave, 0.5 c.c. of pituitrin is administered hypodermically every four hours, although the author is by no means convinced of the usefulness of this preparation.

SUMMARY

In no case of acute appendicitis accompanied by peritonitis, abscess formation, or gangrene, should operation be postponed in the hope that a more suitable period for operation may be arrived at. Supportive treatment can be equally well carried out, after the major focus of infection has been eliminated and after an opportunity has been given for evacuation of toxic material.

By means of a transverse incision placed above the anterior superior spine, adequate exposure can be obtained without the risk of injuring the musculature or nerve supply of the abdominal wall.

If prior to incision of the peritoneum the wound in the abdominal wall be properly prepared and bipped, ultimate infection of the wound can be avoided.

In every case the appendix should be removed, or at least that part of it attached to the cecum, and the stump ligated. As a rule it is advisable to attempt to bury the stump.

In all severe cases, particularly those in which gangrene is present or in which the

patient's life appears to be in jeopardy, a technique whereby the abdominal wound is left unsutured and the whole area involved in the inflammatory process packed with liquid paraffined gauze to which bipp has been added, has in the author's hands appeared to be followed by a distinct lessening in the mortality rate. Later closure of such wounds should be accomplished after four to ten days by delayed primary, or by secondary, suture, with the return of the abdominal wall to normal.

The technique described in this article has appeared to lessen the number of deaths, has cut, by at least one-third, the number of hospital days required for treatment and has eliminated the accidental development of fecal fistulae and of post-operative herniae.

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* Continued from p. 51.

RELATIONS BETWEEN APPENDICITIS & PYELITIS*

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IN discussing differential diagnosis of appendicitis it is customary to mention kidney stones which may cause a renal colic and be mistaken for an acute inflammatory condition of the appendix; some authors also state that Dietl's crises, caused by floating kidney, may simulate appendicitis; relatively few writers however mention the simultaneous occurrence of pyelitis and appendicitis and discuss the pathogenesis of these conditions. The importance of early recognition of the true nature of these cases is obvious because the overlooking of an acute fulminating appendicitis may have grave consequences and even cause a fatal outcome. The presence of pyuria may induce the physician to attribute all the symptoms to a pyelitis and to refrain from a life-saving operation. The following case illustrates the difficulties of the diagnosis:

Mr. N. K., twenty-three years of age, was referred to the author and admitted to the Lutheran Memorial Hospital, September 21, 1931, record no. 20154, with complaints of vomiting and pain in the right lower quadrant of the abdomen. According to the patient's statement, the pain started thirty-six hours previous to admission to the hospital. The pain was localized in the umbilical region and was severe at first; it gradually became dull and aching in character and shifted to the right lower quadrant and to the right loin. The patient also complained of dysuria, preceded by frequent micturition.

Past History: Circumcision in infancy; measles at the age of eight; tonsillectomy at the age of twelve. Venereal diseases denied. Family history of no importance.

The *physical examination* gave negative findings with the exception of the abdomen which was rigid on both sides, tender and moderately distended; there was also tender-

ness on deep pressure in the right flank. The Rovsing's sign was positive, i.e. pain was experienced in the appendix region after deep pressure has been applied and suddenly relieved in the region of the sigmoid. The temperature was 99.8°F. and the pulse 76. The patient's tongue was moist and coated.

A catheterized specimen of urine was obtained; the urine had a cloudy appearance and a deep yellow color; the reaction was acid; the specific gravity was 1030; albumin and sugar were absent; leucocytes were present in great numbers; they were forming clusters; there was a considerable number of epithelial cells and shreds of mucus. The benzidin test was negative; there were few granular casts.

The *blood examination* gave the following results: 4,650,000 red blood corpuscles; 18,700 leucocytes; polymorphonuclear neutrophils 83; small lymphocytes 9; large lymphocytes 3; large mononuclears 3; transitional 2; hemoglobin 85 per cent.

In view of the fact that the rigidity and tenderness were not confined to the right lower quadrant but were also present in the left lower quadrant and in view of the positive Rovsing's sign it was concluded that an acute appendicitis must be present and that the pyelitis was of a secondary nature.

An *operation* was performed and an acutely inflamed appendix found in the lumbar region, ascending on the lateral side of the cecum; a small amount of serous exudate was present in the peritoneal cavity. Appendectomy was performed.

Gross description of the specimen was as follows: appendix 7 cm. long, green-red in color; the lumen dilated and filled with pus. Under microscopic examination, the mucosa and muscularis were found to be covered by and filled with polymorphonuclear leucocytes. The pathological diagnosis was suppurative appendicitis.

The patient made an uneventful recovery and the urine cleared up within ten days spontaneously, without any medication.

* Submitted for publication November 12, 1931.

In this case evidently the appendicitis caused a secondary infection of the renal pelvis or ureter; this condition cleared up after removal of the primary focus of infection, due to rest in bed and a bland diet.

The pain in the right flank and the urinary findings were justifying the diagnosis of pyelitis and appendicitis would have been excluded if it were not for the tenderness in the left lower quadrant and the positive Rovsing's sign; both symptoms are not present in pyelitis.

The following case is more interesting because the infection apparently spread in the opposite direction, i.e. the appendicitis formed a complication of pyelitis.

V. S., a girl six years of age, was first seen by the author July 30, 1931. The mother stated that the child had been sick for the last three weeks but she was up and around most of the time. At the onset of the disease the child had a skin eruption diagnosed by a physician as chicken-pox, and shortly afterwards she began coughing; another physician at that time diagnosed whooping cough. One week before the examination by the author, the girl began complaining of pain in the right kidney region and was taken severely ill. She vomited once during the onset of the pain; ever since then she had been confined to bed.

Past Medical History: scarlet fever, measles. Surgical history: tonsillectomy at the age of four; drainage of an abscess of the right leg after scarlet fever at the age of five. The family history did not present anything of importance.

At the *physical examination* it was found that the child was considerably undernourished. There were no râles or dullness over the lungs. There was a distinct systolic murmur over the mitral area; the second pulmonary tone was accentuated. There was a pronounced tenderness in the right kidney region and the patient pointed to the right flank as to the place of greatest pain. The abdomen was soft, not painful even at deep pressure and not distended. The mother stated that the child was constipated. The skin showed numerous marks of former pustulae, possibly originating from chicken-pox. The glandular and neuromuscular systems, bones and joints gave

negative findings. The temperature was 102°F., pulse 120, respiration 18.

The *urine* examination gave the following findings: appearance cloudy, color yellow, reaction acid, specific gravity 1.015, albumin +, sugar absent, casts absent, many epithelial cells, very many pus cells, few erythrocytes, few urates.

Rest in bed, liquid diet and alkalies were prescribed. Four days later the child was brought again to the office and being severely ill was immediately sent to the St. Elizabeth Hospital, where she was admitted August 3, 1931, case no. 2257.

Now the clinical findings were entirely different; although there still was tenderness in the right flank, the child complained of severe pain in the appendix region; the abdomen was rigid on both sides, especially in the lower half, and tender to touch. The child was coughing and a few moist râles were heard over both lungs posteriorly.

The x-ray report was as follows: "The film made of the chest shows a slight congestion of the right lung, a slight degree of pleural thickening and swollen hilum glands as well as an increase in peribronchial fibrosis. These findings could result from any acute systemic inflammatory process. There is no evidence of any definite pulmonary pathology at this time."

Urinary findings were as follows: cloudy appearance, straw color, acid reaction, trace of albumin, no sugar; specific gravity 1.010; casts absent; some epithelial cells; very many pus cells, forming clusters; very many red blood corpuscles; few urates.

The *blood* examination gave the following result: red blood corpuscles 4,360,000; hemoglobin 65 per cent; leucocytes 28,300; polymorphonuclears 77, eosinophiles 1, basophiles 1, lymphocytes 21.

The diagnosis of pyelitis with secondary appendicitis was made and the child was operated on the day of admission. A serous exudate was found in the peritoneal cavity; the appendix was acutely inflamed. An appendectomy was performed. After the operation the temperature of the child ranged between 100°F. and 104°F. for eight days. Afterwards the temperature gradually subsided and the child made an uneventful recovery. The *urine* examination eight days after the operation gave approximately the same findings as

before the operation, but red blood corpuscles were absent. Three weeks after the discharge from the hospital the urine was free from pus and the child was in an excellent physical condition.

In this case the pyelitis probably developed as a sequel of whooping cough or chicken-pox. As the sickness began with pyuria and pain in the right kidney region without any apparent involvement of the intraperitoneal organs and the symptoms of appendicitis appeared a few days later, we are justified to make the conclusion that probably the appendicitis developed following pyelitis. Pyelograms were not made in either of these cases because the severe acute illness made such a procedure not advisable. Intravenous injection of iothion was also given up for the same reason.

Maloney and Cracco¹ made a survey of 7300 operations performed in the Woman's Hospital of New York; complications of pyelitis were found in 24 cases, 0.33 per cent. In their opinion trauma and shock of operation lower the resistance of the patient and foci of infection which would be held in control under normal conditions, would now have opportunity of starting lesions in various regions of the body, especially in the kidneys. M. Thompson² found among 200 cases of acute appendicitis 3 cases associated with pyuria. The author believes that the pyuria is due to a secondary inflammation of the portion of the ureter adjacent to the appendix. Van Duzen³ found among 300 cases of pyelitis 23 cases, 7.6 per cent, due to appendicitis. He states that he frequently sees cases of retrocecal appendicitis with pain along the course of the ureter, urinary frequency and hematuria. Hunner⁴ described a case of acute pyelitis due to acute appendicitis. Rosenkranz⁵ reports a case of perityphlitic abscess followed by pyelitis. Proust⁶ observed chronic pyelonephritis with acute exacerbation in the course of chronic appendicitis, cured by operation. Franke⁷ discusses the various possible paths through which the infection may spread from the appendix to the renal pelvis. In his opinion three ways are possible: 1, hematogenous; 2, ascending; 3,

lymphatic. Petruschky⁸ and Pilcher⁹ expressed the opinion that lymphatics must exist between the ascending colon and the right kidney. Stahr¹⁰ showed that the lymphatic vessels of the kidney anastomose with the lymphatic vessels of the renal capsule and that lymphatic vessels from the lateral wall of the cecum and ascending colon can be traced to the retroperitoneal space, running from there over the capsule of the right kidney to the lumbar plexus. This author injected the lymph vessels according to Gerota's method and succeeded in demonstrating communications between the appendix and right kidney. He states that on the left side no parietal paths could be found but he assumes that the mesenteric path probably communicates with the left kidney. This author claims that the lymphatic stream has the direction from the intestines to the kidneys. Artificially created constipation in rabbits caused colon bacilli to enter the lymphatic vessels from the intestines. This experiment shows that intestinal stasis may cause a bacteriemia of the lymphatic vessels and a secondary infection to the renal pelvis.

One occasionally sees acute appendicitis accompanied by pus, blood and bacteria in the urine when the clinical picture is one of septicemia. The cases reported here do not belong to this class. As seen from the short survey of the literature cases have been reported where appendicitis was complicated by pyelitis. It seems most probable that the lymphatics between the appendix and the renal pelvis form the pathway for the infection. If the infection had spread through the blood stream, bacteria would be found in the blood but the blood cultures gave negative results in both cases. There is also a possibility of the infection spreading directly from the appendix to the renal pelvis, facilitated by the topographic proximity of these two organs.

In the available literature no case could be found similar to the second case reported here, where the pyelitis caused a secondary appendicitis. In this case we

must assume that the infection spread by contiguity or through the lymphatics, but if this latter theory is correct, the bacteria must have travelled in a direction opposite to the direction of the lymph flow.

The importance of early recognition of the true nature of such cases does not require any emphasis because it is evident that laboratory findings may lead to the diagnosis of pyelitis and a lifesaving opera-

tion may be postponed or not taken into consideration at all. It is not the author's intention to minimize the importance of laboratory findings but a coordination of them with the results of the clinical examination is essential. No appendectomy should be performed without preliminary urine examination but it also should be kept in mind that the presence of pus in the urine does not exclude the possibility of appendicitis.

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CARCINOMA OF THE APPENDIX

IN A GIRL OF TWENTY*

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THIS case is reported on account of the extreme rarity of primary carcinoma of the appendix in one so young. It is

of the cases. The mesenteric and retroperitoneal nodes first become involved.

Miss G. B., aged twenty, from Philadelphia.



FIG. 1. Low power of central portion of growth. 10 X ocular, 6 mm. objective (Zeiss), Bellows length 20 cm.



FIG. 2. Area showing infiltration of muscularis. 10 X ocular, 6 mm. objective (Zeiss), Bellows length 20 cm.

quite probable that most of the things that are considered rare in medicine would be less rare if all the cases were recorded. No doubt there would be many more cases of carcinoma of the appendix found if every appendix removed were subjected to pathological study. Ewing remarks: "It is interesting to note how the recorded cases of this form of carcinoma have increased in proportion to the attention given to it."

Batzdorf lists 60 cases of primary carcinoma of the appendix out of 13,083, or 0.46 per cent; Batzdorf refers to 186 recorded cases. The age of incidence is from five to eighty years, but most of the cases occur in the third decade.

Extension of the process is relatively uncommon, occurring in about 6 per cent

At the age of two years she had diphtheria. Following that illness she had attacks of pain associated with screaming. According to her mother she described the pain as being in her stomach and buttocks. These attacks would last two or three weeks intermittently. At four years of age she had a prolonged siege of furunculosis. She then had attacks of vomiting which seemed uncontrollable and which would last two or three weeks. When she was seven, she had a copious discharge of pus from the vagina; the discharge lasted about three weeks and there was never any further trouble. This suggests a possible abscess of the vagina or the uterus with spontaneous evacuation. Her menses were established at twelve years of age and were regular and normal. She has been well since that time, but for the past six months she has complained of soreness and pain in her right side. She had what was diagnosed as

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appendicitis about four years ago, but she was not operated upon.

She now weighs 128 lb. and is well developed

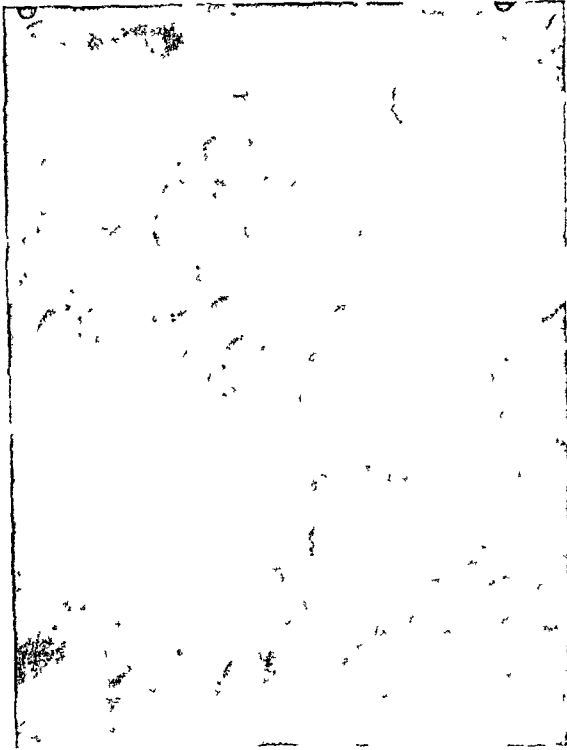


FIG. 3. High power of tumor cells. 20 X ocular, 8.3 mm. objective (Zeiss), Bellows length 20 cm.

and well nourished. On August 16, 1931 she was seized with pain and vomiting. There was no elevation of temperature, pulse 90 and she was menstruating. The next day the pain became localized over the appendix. On account of her previous attack it was thought best to remove her appendix.

On opening the abdomen her appendix was found to be bound down with adhesions. It was not particularly inflamed but was much enlarged and thickened, whitish in color and had a doughy feel on palpation. The cecum was much distended, to the size of a grapefruit. The appendix was removed and the adhesions released. On account of the distention of the cecum and colon it was feared she might have some obstructive condition, which was searched for but not found. The regional glands about the appendix were not enlarged. The uterus, tubes, and ovaries were normal. She made an uninterrupted recovery and did not suffer from postoperative distention or vomiting. Avertin anesthesia was used. Our

observations in about a hundred or more abdominal cases has been that patients suffer very little from gas distention and vomiting, postoperatively, after avertin anesthesia, and convalescence is usually smooth.

On opening the appendix the walls were found to be much thickened and of a whitish fibrous consistency with small nodules. There was no pus in the appendix but a small amount of fecal matter was found.

The pathological report is as follows:

Gross Examination: The specimen consists of an appendix 6 cm. long which has been sectioned longitudinally in the operating room. It is not particularly congested and presents no striking gross changes, suggesting any marked or acute inflammatory reaction. The distal end, although not showing any very pronounced difference in consistency, being, if anything, somewhat doughy to palpation, is somewhat thickened. Paraffin sections were cut after formalin fixation.

Microscopic Examination: The striking feature of the sections is the presence of numerous large masses of epithelial cells which, in general, show a gland-like conformation. These apparently arise primarily in the mucosa where the alveolar arrangement is most marked. They also occur, however, in long fimbriate processes and in smaller groups without any definite arrangement which are found throughout the submucosa and muscularis so that practically the entire thickness of the appendix is involved. Only an occasional mucous gland is found. The epithelial cells of the neoplasm are well differentiated. There are moderately numerous mitotic figures.

Histological Diagnosis: Alveolar carcinoma. The immediate histological problem in the study of the sections was the differentiation of the lesion present from the benign embryonal tumors occasionally encountered in the intestinal tract, and still more occasionally in the appendix, and which, because of their histological structure, are commonly spoken of as carcinoid.

Grossly, these occur as single or multiple, firm, opaque nodules. On microscopic examination these are seen to lie in the mucosa or submucosa and, histologically, to be composed of compact, densely stained masses of cells with occasional traces of alveolar conformation, the entire picture strongly resembling a basal celled carcinoma.

While in their simplest form these carcinoid tumors are probably not true tumors and represent either developmental abnormalities or the product of inflammatory heterotopia, the fact remains that, not infrequently, they are precursors of true malignancy with the usual metastatic accompaniment.

For this reason some observers speak of them as pseudocarcinoma and others regard them as true carcinoma although of low grade malignancy.

The distinction, therefore, may be more apparent than real and is the subject of dispute.

In the case at hand, while the growth began in the mucosa, it is found also in the submucosa and infiltrating throughout the muscularis and mitotic figures are relatively numerous.

These findings seem to justify placing it among the true carcinomata although, as suggested by the definite differentiation of the cells, of low grade malignancy.

The general characteristics of the sections are shown in the microphotographs.

Ewing significantly remarks: "The occurrence of a specific type of carcinoma in an atrophying organ, which is often the seat of chronic inflammatory changes is of much theoretical interest. Its peculiar structure and benign course serve to emphasize the principle that each organ probably has its own form of cancer."¹

¹Ewing J. Neoplastic Diseases, Ed. 2, Phila., Saunders, 1922.



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* Continued from p. 15.

ACUTE APPENDICITIS CAUSED BY FOREIGN BODIES

REPORT OF A CASE OF A TOOTH LODGED IN THE APPENDIX*

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FOREIGN bodies in the appendix were first described as incidental observations noted during postmortem ex-

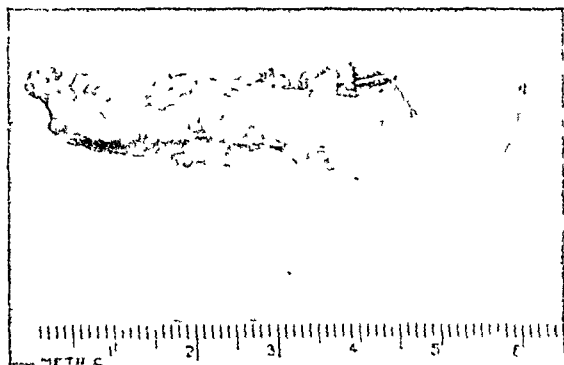


FIG. 1. Partially opened appendix with tooth in situ. Inflammatory swelling and congestion involves that portion of appendix distal to tooth.

aminations. In 1743 Hevin¹ found in the appendices of persons, who during life had eaten a great deal of game, a large quantity of shot which apparently led to no symptoms or lesions. Subsequent reports likewise attached no clinical importance to foreign bodies of the appendix until 1759, when Mestivier² reported the case of a man, aged forty-five years, who developed in the right side of his abdomen a large abscess from which foul pus was evacuated. The patient died and at autopsy an eroded pin was found in the lumen of the appendix. This case, the first reported instance of acute appendicitis, aroused the suspicion that foreign bodies and inflammation of the vermiform appendix were etiologically related. As more and more cases were observed the conception became generally accepted that foreign bodies were frequent and constituted a common cause of appendicitis. As a matter of fact, the doctrine became established that true foreign bodies

comprised the usual basis for appendicitis. However, what were considered seeds of various kinds proved in the light of subsequent knowledge to be simple coproliths of endogenous origin. Further investigation led to the disclosure that true foreign bodies were only exceptionally responsible for acute appendicitis. That the presence of appendiceal foreign bodies is actually uncommon is exemplified by the reports of a number of observers. Mitchell³ found two foreign bodies in 250 cases of appendicitis, Kelly⁴ four in 1000 cases, and Bell⁵ five in an equal number of cases.

The large variety of foreign bodies that have been found in the appendix includes pins, needles, shot, revolver bullets, screws, nails, collar buttons, seeds and bones of various kinds, pieces of wood, worms, pieces of egg shell, barium sulphate, hair, bristles, pebbles, splinters of porcelain, teeth, and metallic mercury. Of the foregoing objects the most frequently found were pins, which comprised 19 of the 110 foreign bodies reported by Berger.⁶ Among the least common were teeth, only two instances of which were discovered in the literature.

Upton⁷ reports the case of a man, aged seventy-nine years, who swallowed a tooth and about six weeks later developed what appeared to be a strangulated right inguinal hernia. Incision over the hernia led to the evacuation of a large quantity of pus and the tooth. The remains of the "sloughed off appendix" were found at the internal ring. Christeller and Mayer⁸ report the case of a man, aged fifty-three years, who was operated upon by Pick for an acute appendicitis. The appendix contained a tooth, the root of which had produced a perforation. In both of these cases the

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presence of the tooth was considered the cause of the acute appendicitis. A third case in which a swallowed tooth led to acute appendiceal inflammation recently came under our observation. The rarity of the affection appears to warrant its publication.

CASE REPORT

Mrs. M. M., aged fifty-five years, was seen by us thirty-six hours after the onset of a diffuse lower abdominal pain which in the beginning was continuous and dull in character. After approximately twelve hours the pain became more severe and colicky and localized in the right lower quadrant. The patient had noted nausea but did not vomit until twenty-four hours after the appearance of the pain. A cathartic was taken on the day of onset, resulting in a watery bowel movement the following day. The remaining history was essentially negative.

Physical examination revealed a well-developed adult white woman who seemed acutely ill and somewhat listless. The temperature was 100.8°F., the pulse rate 86, and the respiratory rate 22. Abdominal examination disclosed tenderness and rigidity over the entire lower abdomen, most marked, however, on the right side. No masses were palpated. The general physical examination was essentially negative, except for the absence of the right lateral incisor tooth. The white blood count was 18,000. A diagnosis of acute appendicitis was made and immediate operation was advised.

The abdomen was opened through a McBurney incision. The peritoneal cavity contained a thin, gray-white, non-odorous exudate. The appendix, which was easily delivered, was swollen, rigid, and covered with a fibrinous exudate. On its antimesenteric border, at a point between its proximal and middle thirds, there was a pinhead sized perforation. Appendectomy was performed and the abdomen closed without drainage.

Upon opening the excised appendix, an artificial tooth (Richmond crown) was found just beyond the proximal third, distending and occluding the lumen. The post of the tooth had penetrated the wall of the appendix at the point of perforation. The distal portion of the appendix was filled with a mucopurulent exudate.

Following the operation the patient readily acknowledged having swallowed the tooth twenty-four hours prior to the onset of her symptoms but had considered the accident too insignificant to mention at the time she presented herself for diagnosis and treatment.

COMMENT

Of the factors which determine whether a small foreign body will lodge in or pass beyond the appendix, the specific gravity appears to be important. In the series of 110 foreign bodies reported by Berger,⁶ forty-five or 40 per cent were metallic objects of high specific gravity. Heavy particles upon entering the cecum tend to gravitate to its lowermost portion, a point from which the appendix usually arises. In the presence of a patent appendiceal orifice the foreign body can descend further into the lumen of the appendix. Normally the appendix can empty its contents into the cecum by its own peristaltic activity.⁹ If, however, the foreign body is heavy, the peristalsis of the appendix will be insufficient to expel it and as a result it will be retained in the appendix indefinitely. The weight of the Richmond crown in our case was an important factor in its becoming lodged in the appendix. The lighter foreign bodies may enter the appendix with the normal fecal content. Their retention, however, occurs in the presence of kinking, angulation, stenosis, or insufficient peristalsis of the appendix.

The change in the appendix that results from a foreign body in its lumen varies with the contour of the object. Sharp and pointed foreign bodies may injure the mucosa as soon as they enter the appendix and give rise to an acute inflammatory process with not infrequent perforation. Many of these foreign bodies, especially pins, may remain latent in the appendix. Pins have been found eroded and incrust-ed in appendices which were excised long after the ingestion of the foreign objects.

Smooth foreign bodies are less prone to produce primary injury to the mucosa although they may be of sufficient size to

partially or completely obstruct the lumen of the appendix. A complete obstruction may give rise to a mucocele or in the presence of infection to empyema of the appendix. A partial obstruction may produce no immediate change, but the constant irritation of the foreign body may give rise to varying degrees of chronic inflammatory reaction of the appendiceal wall.

The symptoms that are caused by a foreign body in the appendix may be lacking entirely or vary from mild manifestations to those characteristic of acute appendicitis. The absence of clinical symptoms usually occurs as a result of foreign

bodies that produce no primary injury to the mucosa and no obstruction. Mild recurrent attacks of pain in the right lower quadrant of the abdomen may result from those foreign bodies that cause partial obstruction or chronic inflammatory changes of the appendix. The symptoms of acute appendicitis occur when there is an injury to the mucosa which acts as a portal of entry for secondary acute infection of the appendix. The symptoms in the case herein reported were due to the injury of the mucosa by the post of the crown together with complete obstruction of the lumen and ulceration of the mucosa of the appendix at the site of the tooth.

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DIAGNOSTIC SIGN OF CHRONIC APPENDICITIS*

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“CHRONIC appendicitis” is quite a common diagnosis nowadays; yet the general opinion about the syndrome is rather vague. The pathological picture is not properly expressed by the clinical name which indicates chronic inflammation. What we find by biopsy are mostly adhesions and residues of more or less acute attacks of inflammation. To be correct we should therefore call the condition recurrent appendicitis.

The symptomatology of the disease is also somewhat obscure. Pain is usually not very marked and roentgen-ray examination alone does not seem to offer definite proof either. A residue of barium in the cecum after seventy-two hours, constant filling of the appendix for many hours or irregularities of filling, etc., are not enough evidence for an absolutely sure diagnosis. We should never forget that the appendix has a peristalsis just like any other part of the intestines; it may happen that we take the roentgen-ray plate at times when the appendix is either just filled or has just emptied itself.

For a number of years I have paid particular attention to the condition of the abdominal wall in all cases where complaints were made about pains in this region. The examination was made by testing the thickness of the skin and the adipose tissue on corresponding spots of the right and left sides between the anterior superior iliac crests, using the thumb and index finger. In doing this one must be sure to grasp the same amount of tissue on both sides; otherwise the comparison will be faulty. There is very often a marked difference in the thickness of the

two sides. The right side is decidedly thinner than the left one. Whenever this difference was found, the operation revealed pathological changes of the appendix or of the cecum.

It is understood that these conditions must have existed for some time to have caused the difference in thickness. We are doubtless dealing here with a real atrophy of the subcutaneous tissue and the underlying muscle. Chatzkelson¹ sees the explanation in the permanent contraction of the muscle which diminishes the action of this part of the abdomen and compresses the blood vessels, thus decreasing the circulation of the tissue above. This explanation does not seem correct. Increased contraction means increased activity and always produces hypertrophy. Looking for similar conditions in the body, we find the marked atrophy of the thorax muscle and subcutaneous tissue in chronic tuberculosis, which is well known as “lagging” of the diseased side. It is likely that we are dealing with the same process here, which would mean diminished activity of the right hypochondrium as a protection reflex.

It seems worth while to try for this simple sign in every case where a pathological condition of the appendix or of the cecum is suspected, because its rather uncertain symptomatology needs additional evidence for diagnosis. Whenever we find this difference in the thickness of the skin and the adipose tissue, we can be sure of a pathological condition of this region, usually recurrent appendicitis.

¹ Chatzkelson, B. *Zur Symptomatologie der Appendicitis Chronica. Münch. Med. Wschr.*, 76: 664, 1929.

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ACUTE PERITONITIS IN CHILDHOOD*

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ACUTE peritonitis, which occurs most frequently in childhood, still presents many difficulties to the general practitioner, surgeon and pediatrician. Given a case of a child with high temperature and abdominal distention, these signs alone arouse immediate anxiety in all concerned, and it is here that the closest cooperation by those interested in all fields is essential before therapy is instituted. Here also, one encounters a vast diversity of existing opinion regarding the etiology, diagnosis, prognosis and treatment of this entity. In spite of all that has been written on this subject, little help is obtainable because of a similar difference of opinion between the authors found in the literature. For the purpose of clarifying this situation, 42 consecutive cases of acute peritonitis in children occurring over a period of three years (1926-1929) were carefully studied and divided into three classes, namely, (1) pneumococcic peritonitis, (2) non-pneumococcic peritonitis, and these were compared with (3) acute secondary suppurative peritonitis (ruptured viscus). In this group were 9 cases of pneumococcic peritonitis, 13 of non-pneumococcic and 20 cases of acute secondary suppurative peritonitis due to a ruptured viscus. Gonococcal, tuberculous and other forms of peritonitis were not encountered.

ETIOLOGY

In all groups studied, age seemed to play no part as an etiological factor and varied from six weeks to thirteen years. The female sex as shown by McCartney,¹ Fraser² and others was more frequently affected by pneumococcic peritonitis in sharp contrast to the other groups. Environment, family history and birth were

of negative value, and contrary to the findings of Fishbein³ and Foote,⁴ our children were usually well nourished. This entity rarely appeared as a primary disease, but more rightly as a complication of some other infection. It was felt that the classification into primary and secondary peritonitis was misleading. In the pneumococcic group, upper respiratory infections (6 cases), and nephrosis (2 cases) were the primary causes. Peculiarly of the 260 cases of pneumonia occurring in children during this same period of time in the same institution not one was complicated by pneumococcic peritonitis. Rolleston⁵ uses this as an argument against its being a blood stream infection. Whether the organism reaches the peritoneum through the blood stream, intestinal tract or other source is still debatable. Yet it would appear as though the source was in the upper respiratory tract and not by extension through the diaphragm, lymphatics, vagina or other suggested sources. This is also true of the non-pneumococcic group, except that the cause of the upper respiratory infection was revealed as a streptococcus in most of the cases (8 cases). Other organisms found in the peritoneum alone or with streptococci were *B. coli* (2 cases), staphylococcus (1 case) and unidentified organisms (4 cases).

Schwarz and Kohn⁶ described cases of nephrosis with peritonitis complicating rhinopharyngitis. Most of their patients showed either a positive pneumococcus or streptococcus blood or peritoneal fluid culture, which fact may possibly point to the relationship between upper respiratory infections, nephrosis and peritonitis. The rôle which the kidney plays in these infections is certainly worthy of further study.

* From the Jewish Hospital of Brooklyn. Submitted for publication August 19, 1931.

In acute secondary suppurative peritonitis due to a ruptured abdominal viscus, the staphylococcus, streptococcus and *B. coli*, were the predominating organisms found, and in only 4 fatal cases in the latter group could the peritonitis possibly be traced to some other primary disease entity, which was in sharp contrast to the other two groups. All these last fatal cases were seen within three days of the onset and were not considered to have been neglected.

CLINICAL PICTURE

Contrary to general belief, on inquiry our cases in the pneumococcic and non-pneumococcic groups did not show a rapid onset. This usually occurred anywhere from ten days to three months after the beginning of the original illness. Clinically, it was found that the *symptomatology* between the first two groups and the severe cases of the acute diffuse secondary suppurative peritonitis could not be differentiated. The cardinal symptoms and signs in the first two groups found in all cases were high temperature, abdominal distention, severe toxemia and abdominal pain and tenderness. Very suggestive symptoms and signs were high pulse and respiration rates, abdominal localization, vomiting and skin manifestations. The *temperature* usually started high at the onset and remained elevated (102–107°F.) during the entire illness with morning remissions of one to two degrees, never reaching normal. Temperatures as high as 109°F. were recorded and when recovery occurred it was usually by lysis, over a period of seven to fourteen days. Except in the terminal premortal stages, the temperature of the acute secondary suppurative group rarely reached above 102°F. The 6 patients in this last group who did record high temperatures died. Four of these incidentally were those complicated by some other disease entity. *Distention*, except in the secondary suppurative appendicitis, was discovered sooner or later. Two-thirds occurred early in the disease. Free fluid was elicited in only 10

per cent, while tympanitis was present in two-thirds of the cases, whereas in the ruptured appendiceal group this sign occurred in only one patient who recovered and in all the 6 patients who died. In the latter group (acute secondary suppurative appendicitis) it usually occurred late in contrast to the other groups. *Abdominal pain and tenderness* were present in all cases studied. The pneumococcic and appendiceal cases showed a tendency to localize early and in the last group, the pain was spasmodic and cramp-like in character in the majority of children. *Toxemia* with marked prostration and stupor occurred in the majority of patients, whereas, this symptom occurred in only 35 per cent of the appendiceal group. *Pulse and respiration rates* were constantly high, the former ranging between 120 and 180, and the latter between 45 and 60, these signs occurring in only 25 per cent of the appendiceal cases. A lowering of the pulse rate in spite of a high temperature was a good prognostic sign. *Abdominal localization* demonstrated itself by the palpation of abdominal masses in three-fourths of the pneumococcic type, the favorite sites being the lower right inguinal, lower left inguinal and umbilical regions. Localization also appeared sooner or later in all the appendiceal cases but in less than one-third of the non-pneumococcic group. *Vomiting* of a non-projectile type occurred early in all the acute suppurative cases, in 85 per cent of the non-pneumococcic group and in 50 per cent of the pneumococcic type. *Skin lesions* such as large blotchy areas of erythema appeared frequently and chiefly on the abdomen, face, nose, extremities and back. Other lesions were circumscribed bluish areas of mottling, bluish-green rings around the umbilicus, prominence of superficial veins, and in one case a large bluish-green ecchymotic lesion on the abdomen. No wheal formations were noted. At first it was felt that these lesions were characteristic of pneumococcic peritonitis, but they were also found with similar frequency in the non-pneumococcic type. None of the

appendiceal cases showed skin manifestations. *Abdominal rigidity* occurred in less than one-third of both the pneumococcic and non-pneumococcic groups, yet 80 per cent of the secondary suppurative appendiceal cases showed definite rigidity of the abdominal muscles. *Diarrhea* was an inconstant symptom in all groups and occurred in only one-third of all the patients studied. *Constipation* was just as infrequent. *Nausea*, except in the appendiceal group (90 per cent) was rarely present. *Chills* occurred in only one case. *Cough* appeared more frequently in the other groups (20 to 30 per cent) rather than in the pneumococcic group and *meningeal signs* were present in only one case.

LABORATORY PROCEDURE

The blood count is neither diagnostic or prognostic. The average count (18,000) was no higher in the pneumococcic than in the other groups. However, in the pneumococcic and suppurative types, it would appear that a white cell count above this number offered a better prognosis. It would also seem that the urine was of little significance and precipitin tests were of little diagnostic value. Blood cultures, except in the cases of streptococcic peritonitis where 20 per cent showed positive cultures, were of no value. No blood cultures were taken on the appendiceal group.

Contrary to the belief and findings of Fraser,¹ McCartney² and others, that the infection reached the peritoneal cavity through the genital tract, smears taken from the vagina were negative for pneumococci in all our females. Peritoneal fluid studies by early peritoneal puncture under proper precautions, or at operation, were alone of value. This procedure usually revealed the causative organism. The physical characteristics of the fluid were likewise of no diagnostic importance. Such procedures as nose and throat cultures, spinal fluid studies, and x-rays proved to be of no value.

DIAGNOSIS

From these studies, one realizes that to obtain a correct differential diagnosis in peritonitis in children the organism must be demonstrated by securing it directly from the peritoneal cavity by abdominal puncture. This procedure when done early offers evidence, assisting not only in diagnosis but also in prognosis. Clinically, it would appear impossible to differentiate between the pneumococcic, non-pneumococcic groups and cases of early severe acute diffuse suppurative secondary peritonitis. However, it was noted that most cases of acute secondary suppurative peritonitis (ruptured appendix) could be differentiated from the other groups by its sudden onset, cramp-like abdominal pains, nausea, muscular rigidity, low pulse and respiration rates (comparatively lower) and the absence of prostration, early toxemia and skin manifestations. Careful histories on children are most essential in that a previous history of staphylococcus (abscess) or streptococcus infection (scarlet fever, streptococcic sorethroat, erysipelas, etc.) is strongly indicative of associated infections by these organisms. Likewise, the history of a recent upper respiratory infection or nephrosis in a female is strongly suggestive of pneumococcic peritonitis.

PROGNOSIS

In reviewing our mortality chart, one finds that the non-pneumococcic group offers the worst prognosis with only 15 per cent recoveries. The pneumococcic cases give a better prognosis with about one-third recoveries, whereas the acute secondary suppurative group shows a mortality of only 30 per cent. In the appendiceal group where there was evidence of a complicating disease entity, the prognosis was bad. Where laparotomy is performed early or delayed until the appearance of signs of abdominal localization, one finds a better prognosis. It is also noted that the pneumococcic group lived, on an average, twice as long as the non-pneumococcic. A com-

paratively low pulse in spite of a high temperature and respiration rate was also of good omen. In our cases, signs and symptoms such as vomiting, nausea, and localization of abdominal pain and tenderness, in other words those resembling the acute secondary suppurative peritonitis, presented a better prognosis.

THERAPY

From the histories, it would seem as though those patients who were not treated by drastic cathartics, enemata and other disturbing therapeutic procedures, had a better chance for recovery. This probably prevented distribution of the infectious material and favored early localization. Early laparotomy, with drainage or later when there is definite localization, appeared to offer the best results. Patients upon whom a laparotomy was performed at any time lived on an average of four days longer than the non-operated cases. Complete recovery in all children studied required at least three weeks after laparotomy. Frequent transfusions of whole blood as suggested by some authorities were of no avail. Outside of laparotomy and symptomatic medication for stimulation or comfort, nothing stood out as a therapeutic aid to these patients.

SUMMARY

It would appear from this review that:

1. Pneumococcic and non-pneumococcic peritonitis in children is rarely primary,

but usually complicates infections of the upper respiratory tract, whereas in the acute suppurative peritonitis due to a ruptured viscus (appendicitis) a primary focus of infection is seldom found.

2. The role of the kidney in the extension of the organisms from its source to the peritoneum deserves thorough study as an etiologic factor.

3. Pneumonia in children is rarely complicated by pneumococcic peritonitis.

4. Clinically, cases of pneumococcic, non-pneumococcic and severe cases of acute diffuse secondary suppurative peritonitis cannot be differentiated. However, these entities should be differentiated by symptomatology from acute suppurative secondary peritonitis.

5. Outside of careful early peritoneal puncture for bacteriological study, no laboratory procedure was of diagnostic or prognostic value.

6. Non-pneumococcic peritonitis in childhood offers the worst prognosis (15 per cent recoveries), pneumococcic next (30 per cent) and acute suppurative peritonitis a good prognosis (70 per cent recoveries).

7. Early laparotomy with drainage within three days of the onset or later when there is definite abdominal localization offers the best prognosis.

8. Blood transfusions or other therapeutic procedures were of no avail and the early use of drastic cathartics, enemata or disturbing therapeutic measures are distinctly contraindicated.

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REFLEX SPASM OF THE STOMACH AND DUODENUM

CAUSED BY DISEASE OF THE APPENDIX *

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THE views concerning chronic appendicitis as the cause of gastrointestinal disturbances are varied. Many disturbances in the abdomen have been attributed to the appendix. The diagnosis of chronic appendicitis is by no means easy and no one clinical or laboratory finding is conclusive as Friedenwald and Morrison have recently shown. Rohdenberg¹ in a series of a large number of cases notes a round cell infiltration about the Meissner ganglia which increases until the ganglia have been completely buried. Fibrosis then takes place. From this he concludes that chronic appendicitis is an inflammation resulting from infection and associated with malformation of the sympathetic nervous system. This process is not restricted to the appendix alone but involves organs controlled by the splanchnic sympathetic nervous system in general. According to Rohdenberg the nerve lesions would explain the gastric symptoms, such as attacks of spasm in the gastrointestinal tract and pain.

The cases that we are reporting showed evidences roentgenologically, of filling defects or spastic states in the stomach and duodenum which are consistent with those of ulcer. Some of these cases presented almost typical ulcer symptoms, none responded however to treatment by ulcer regime, and each case showed improvement following removal of the appendix which was pathological in every instance.

Ulcer and cholecystitis are frequently associated with and sequel to chronic disease of the appendix. Solieri² believes that the three diseases are connected by a pathogenetic bond.

Larimore³ states that chronic appendicitis frequently creates a clinical syndrome

simulating duodenal ulcer, which can be differentiated only by gastrointestinal x-ray. There are relatively few occasions in the field of roentgenology when the roentgenological evidence can alone complete the diagnosis or give indications for treatment. This is demonstrated in the following cases which had clinical chronic appendicitis and also defects in the stomach and duodenum which are roentgenologically suggestive of ulcer but which at operation showed no evidences of ulcer by inspection and palpation of the duodenum and stomach. Of course, the possibility of a mucosal defect cannot be excluded, but with the history extending over a rather long period of time it does not seem probable that one would have many small mucosal defects, rather than a definite ulcer with its secondary scar tissue formation. The improvement in duodenal ulcer following the removal of the diseased gall bladders and appendices is well known. A summary of our cases follows:

CASE I. Miss A. aged thirty-two, troubled for many years with pain in upper abdomen at variable times. No food relief. Nausea, belching, regurgitation and vomiting. Bowels regular. Free HCl 56, total acidity 68. Stool examination negative. No response to ulcer diet.

Gastrointestinal x-ray showed a sharp and constant niche deformity in pylorus characteristic of pyloric ulcer. Stomach empty at five and three-fourth hours. Appendix not visualized, slight tenderness. Spastic colon.

Operation: Appendix thickened and vessels injected. No evidence of stomach and duodenal lesion.

One year later she has had no return of symptoms and is well.

CASE II. Mrs. L. aged sixty, troubled for fifteen years. Heavy feeling in upper abdomen at night. No food relief. Constipated. Free from

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cathartics. Free HCl 28, total acidity 55. Stool examination negative. No response to ulcer diet.

normal. One and one-half years later he has had no return of gastric disturbances.

CASE IV. Mr. D., aged forty-two, troubled



FIG. 1, Case I. Arrow indicates marked pylorus spasm. Operation showed pathological appendix, normal stomach, duodenum and gall bladder.

Gastrointestinal x-ray showed constant and definite deformity of duodenal cap characteristic of ulcer. Stomach empty at six hours. Gall bladder visualized, with stones. Appendix not visualized, tenderness at base.

Operation: Chronic thickened gall bladder, dilated common duct, containing sand stones in the gall bladder. Gall bladder and appendix removed. Stomach and duodenum appeared normal.

Ten months following she has had no gastric symptoms.

CASE III. Mr. F. aged thirty-eight, troubled for one and one-half years with pain in upper abdomen two or three hours after eating. Food and soda relieves. Considerable belching. Bowels constipated. Frequent cathartics. Free HCl 44, total acidity 62. Stool examination negative. No x-ray. No response to ulcer diet.

Operation showed chronic appendicitis. Appendix removed. Stomach and duodenum



FIG. 2, Case I. After operation, indicating smooth contour of pylorus. Patient's symptoms relieved.

from fifteen to twenty years with pain in midepigastriac region two to three hours after eating. Bicarbonate of soda gave slight relief. Considerable gas and bloating. Constipated. Frequent cathartics. Free HCl 64, total acidity 88. Stool negative. No response to ulcer diet.

X-ray showed constant and definite deformity of duodenal cap, characteristic of ulcer. Stomach empty at five and one-half hours. Appendix not visualized, tenderness.

Operation: Appendix found thickened and injected. Retrocecal. Removed. Stomach and duodenum normal.

CASE V. Mr. B., aged thirty-two, trouble for nine or ten years. Pain in region of umbilicus; also right lower quadrant one to three hours after eating. No food relief. Belching and gas. Waterbrash. Constipated. Free HCl 30, total acidity 46. Stool examination showed four plus guaiac. No response to ulcer diet.

X-ray showed evidence of adhesions in pylorus and duodenum. Niche deformity

of the lesser curvature. Appendix narrow and constricted at the base. Proximal portion dilated. Tenderness over appendix. Stomach empty at six hours.

Operation: Stomach and duodenum negative. Gall bladder negative. Appendix long, dilated at the tip. There was a Jackson's veil. Appendix removed.

One and one-half years later has had no return of gastric symptoms.

CASE VI. Mr. V., aged thirty-five, troubled for one and one-half years with pain in pit of stomach two and one-half hours after eating; also at night. Food relieves. Belches. Water-brash. Constant frequent cathartics. Free HCl 62, total acidity 76. Stool examination negative. No response to ulcer diet.

X-ray showed pylorus and cap spastic. Previous x-ray showed evidence of duodenal ulcer. Appendix was visualized, dilated and tender. Stomach empty at five hours.

Operation: Stomach and duodenum normal. Appendix thickened, injected and beaded. Appendix removed.

Two and one-half years later good result. No abdominal discomfort.

CASE VII. Mr. B., aged thirty-four, troubled for seven years with more or less constant discomfort in epigastrium. Some food relief. No response to ulcer diet. Belching. Bowels regular. Free HCl 62, total acidity 70. Stool examination negative.

X-ray of gastrointestinal tract showed a definite deformity of the duodenal cap. Appendix barely visualized, slight tenderness. Stomach, duodenum, and gall bladder normal. Appendix thickened, congested, and there was concretion in the appendix. Appendix removed.

One and one-half years later has had no return of symptoms.

CASE VIII. Mr. R., aged thirty-one, troubled for six or eight years with bloating, belching, vomiting, and waterbrash. Bowels constipated. Free HCl 92, total acidity 109. Stool examination negative. No response to ulcer diet.

Gastrointestinal x-ray showed constant deformity of duodenal cap, characteristic of ulcer. Appendix visualized, narrow, constricted, beaded, and tender.

Operation: Appendix adherent and thickened. Appendix removed. Stomach and duodenum negative. Two years later has had no return of gastric disturbances.

CASE IX. Mr. K., aged twenty-eight, troubled for six months. Pain in region of umbilicus immediately after meals. Soda relieved some. Some belching. Bowels constipated. Free HCl 62, total acidity 86. Stool examination negative.

Gastrointestinal x-ray showed constant pyloric defect. Trace of barium in stomach at six hours. Appendix visualized, constricted and beaded. Tender.

Operation: Stomach and duodenum normal. Adhesions about the gall bladder and duodenum. Appendix constricted, injected and thickened. Appendix removed.

Two and one-half years later had no return of gastric disturbances.

CASE X. Mr. L., aged twenty-five, troubled for three years with pain in epigastrium. No food relief. Nausea, belching, and water-brash. Bowels regular. Free HCl 20, total acidity 36. Four plus guaiac in stool. No response to ulcer diet.

Gastrointestinal x-ray showed constant cap deformity. Stomach empty at five hours. Appendix not visualized. Tenderness at base.

Operation: Stomach and duodenum normal. Gall bladder normal. Appendix adherent, retrocecal, and retroperitoneal. Definite angulation. Appendectomy.

Two and one-half years later improved with no gastric symptoms.

CASE XI. Mr. T., aged forty-eight, troubled for one month with generalized pains, nausea, and waterbrash. Constipated. Free HCl 35, total acidity 50. Stool examination negative.

Gastrointestinal x-ray showed constant deformity of duodenal cap. Appendix not visualized. Stomach empty at five and one-half hours. Gallstones and a partial cystic duct occlusion following cholecystography.

Operation: Stomach and duodenum negative. Appendix adherent, thickened and congested. Gall bladder was thickened and filled with stones. Cholecystectomy and appendectomy.

Has had no disturbance of two years.

CASE XII. Mr. J., aged thirty-one, troubled for six years with belching and vague abdominal pains. Free HCl 33, total acidity 57. Stool examination negative. Previously treated for duodenal ulcer without results. This patient while under observation developed an acute appendix which was removed. At that time exploration of stomach and duodenum showed them to be normal.

Has remained well one year following operation.

CASE XIII. Mrs. K., aged forty-seven, troubled for many years with pain in upper abdomen. Free HCl 23, total acidity 40. Stool examination negative.

Gastrointestinal x-ray showed definite deformity of cap. Irritable appendix. Stomach empty at five and three-fourth hours. Stomach and duodenum negative. Gall bladder adherent to first part of duodenum and there were stones. Appendix elongated and thickened.

Operation: Cholecystectomy and appendectomy done.

Remained well for two and one-half years following operation.

CASE XIV. Mr. A., aged forty, troubled for six months. Heaviness in upper abdomen after meals, belching, and constipation. Free HCl 30, total acidity 50. Stool examination negative. Put on ulcer diet without relief.

Gastrointestinal x-ray showed a constant and definite deformity of duodenal cap. Stomach empty at five and one-fourth hours. Appendix visualized. Retrocecal, narrow, constricted at the base, dilated at the tip and tender.

Operation: Stomach, duodenum, and gall bladder normal. Thickened appendix which had shown evidence of an old perforation. Appendectomy done.

Improved after nine months and no return of gastric symptoms.

CASE XV. Mr. H., aged thirty-four, troubled for two years with gnawing in epigastrium, chiefly at night. Food relief. Considerable belching and gas. Constipated.

Gastrointestinal x-ray showed constant and definite deformity of cap characteristic of ulcer. Stomach empty at five and one-half hours. Appendix faintly visualized, beaded, constricted at base, and tender. No improvement while on ulcer diet.

Operation: Stomach and duodenum normal. Appendix thickened and injected. Removed. Improved after one year.

CASE XVI. Mr. R., aged twenty-two, troubled for eleven years. Pain in abdomen and distress after meals. No food relief. Belching.

Gastrointestinal x-ray showed definite deformity of duodenal cap. Appendix visualized. Retrocecal and tender. Congenital fixation of the cecum. High Jackson's veil. Appendix chronically inflamed.

Operation: Appendix chronically inflamed. Appendectomy.

Has remained well for six months.



FIG. 3, Case xv. Arrows indicate deformity of duodenal cap due to supposed ulcer. Operation disclosed normal duodenum. Pathological appendix removed.

In summarizing these cases it is noted that the ages vary between twenty-two and sixty years, 11 however, being between the ages of twenty and forty. There were twice as many males as females. Three of the cases had definitely pathological gall bladders as well as chronic appendicitis associated with the spasms of the stomach. Diseased gall bladders may also cause spasms in the gastrointestinal tract. Fourteen of the 16 patients were constipated. Eight of the 16 gave a typical history of pain one to three hours after meals, but did not respond to ulcer diet. The stomach was empty in all cases between five and six hours. There was a definite hyperacidity; the average acidity of the 16 cases following Ewald-Boas test meal was free HCl 50, total acidity 67. It is quite possible that this might be a factor in the causation of ulcer, namely: chronic appendicitis, causing definite spasm in the region of the

pylorus and the duodenum with associated hyperacidity over a period of time may lead to the formation of ulcer. The x-ray

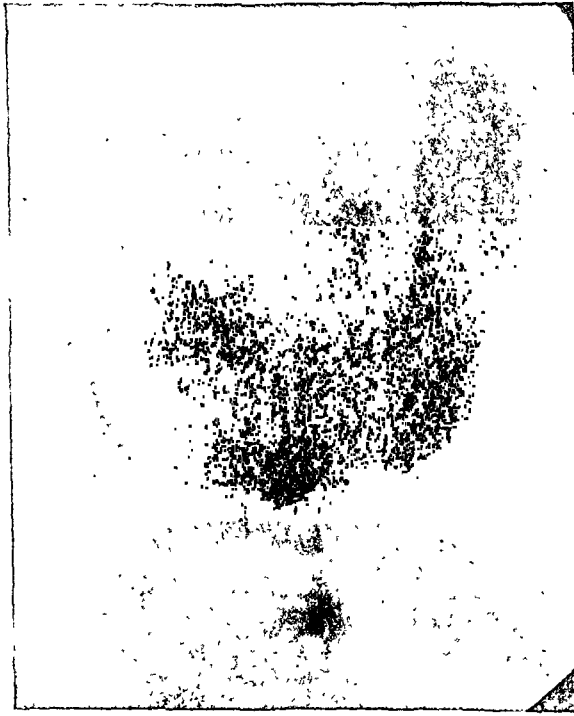


FIG. 4. Case xv. After operation, demonstrating normal contour of duodenal cap. Dietetic regime, postoperative, identical to that before operation.

in all cases showed definite evidences of what we term chronic or pathological appendicitis. In 5 of the cases the appendix was not visualized. Larimore states that the normal appendix is visualized only by

the opportune coincidence of its filled condition to the roentgenographic or fluoroscopic observation. Non-visualization never necessarily means an occluded or non-fillable appendix. The normal appendix can and does empty itself very shortly after the cecum has emptied. By observing the appendix, both fluoroscopically and roentgenographically, at frequent intervals and especially when the cecum is filled, we have come to the conclusion that non-visualization of the appendix, especially when there is tenderness in the region of the appendix and with secondary small intestinal patterns of the irritative form, means a diseased organ.

In all cases a right rectus incision was made, large enough to afford adequate exposure of the stomach, duodenum, and gall bladder. It is not justifiable to remove a supposedly chronically inflamed appendix with a McBurney's type of incision. The patient should receive the benefit of a careful examination of other organs which might be contributing to his symptoms because of unsuspected pathologic changes.

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SPINAL ANESTHESIA*

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ONE hundred fifty-two patients have been operated upon by the writer under spinal anesthesia, comprising

patient's and the surgeon's viewpoint must be accomplished with at least as much safety as with the inhalation anesthetics.

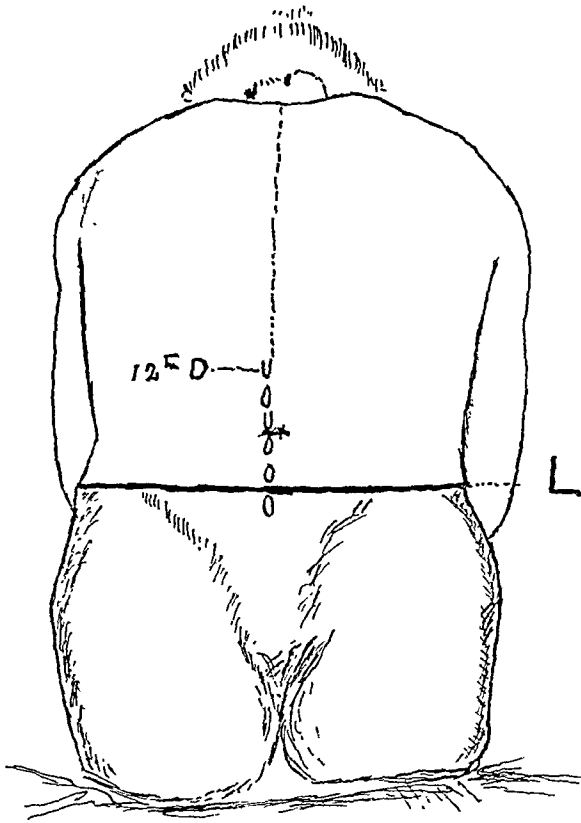


FIG. 1. Sitting posture, patient bowed and head brought down on thorax. Arms brought over sides of abdomen and pressing in. Feet should rest comfortably upon stool. x, Most useful place to introduce needle. L, Imaginary line drawn across crest of ilia, being fourth interspace. Note that needle is introduced second interspace above by feeling spines of vertebrae. (After Labat.)

a variety usual to any one doing general surgery. In using spinal anesthesia we must achieve, from the patient's standpoint, a painless and insensitive field. From the surgeon's standpoint to the foregoing must be added accessibility to the pathological process. Thirdly and most important of all, the objects both from the

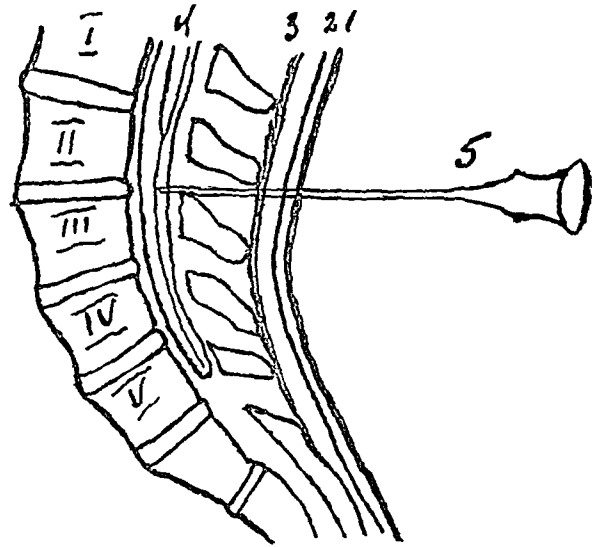


FIG. 2. Lumbar spinal canal and vertebrae. 1, Skin. 2, Lumbosacral fascia. 3, Supraspinous ligament. 4, Cauda equina beginning at upper end of second lumbar vertebra. 5, Needle in position at second lumbar interspace. Note position of needle at posterior compartment of spinal canal.

There will probably never be a foolproof anesthetic, but with due carefulness and foresight spinal anesthesia is as safe as any evolved, causing less morbidity. Susceptibility to any medicament, anesthetic or otherwise, is varied, being different even in a given individual at different periods. In the early days of spinal anesthesia many outward results were due partly to crude drugs and partly to faulty technique. Jonesco, Babcock, Labat and many others have used spinal anesthesia with unvarying success. Koster recently reported 6000 cases in which one fatality could be ascribed to the anesthetic. Many surgeons advocate spinal anesthesia for cases of extreme risk. An anesthetic used and

* Read before the Hurley Hospital Staff Clinical Conference, Nov. 15, 1931.

preferred in extreme cases surely ought to be recommended in the ordinary case.

The laity as well as many of the profession should be educated to the benefits of spinal anesthesia. A good many millions of spinal anesthetics have been given of late and the popularity of this form is increasing, due no doubt to the approximate absence of after-effects on the patient. The relaxation induced by spinal anesthesia is almost complete; it allows the surgeon greater accessibility to the pathological process with smaller incisions and the necessity of huge retractors is lessened. The surgeon must not regard the soft tissues lying between the pathological process and the outside as of no consequence. Skin, fascia, muscle tissue and peritoneum have definite functions and layers; scars should be as small and as neat as possible. Metal retractors, especially self-retaining retractors, should be avoided whenever possible. Their restricted use will give the patient more postoperative comfort and the surgeon less anxiety. Postoperative vomiting and ileus no doubt owe a great deal to rough usage of the tissues by retractors.

Spinal anesthesia is induced by some form of novocaine introduced into the spinal canal, where it is carried by the spinal fluid to the sensory and motor roots. The sensory roots have a greater attraction for the drug than the motor roots. Personally I feel that there are no contraindications to spinal anesthesia. Some surgeons warn against the use of spinal anesthesia in patients with extremely high or low blood pressure, basing their contention on the sudden drop of pressure sometimes occurring in the course of anesthesia, which alarms one who has not given many spinal anesthetics. Many of my patients did not experience a great drop in blood pressure; some had only from 20 to 40 points' drop and a few, in whom the drop appeared alarming, came through just as well. Not a few fell asleep during the operation. The only contraindication I observe is extreme neurosis. Obesity and cardiac

enlargement are not to be regarded as contraindications if proper precautions in technique, discussed later, are followed.

The oldest patient operated on by me under spinal anesthesia was sixty-eight years of age, the youngest eleven years. There were 22 patients weighing over 180 lbs. and 3 of the patients weighed over 250 lbs. There were 6 patients with a blood pressure of 190/110 and over. There were 4 cases of ruptured ectopic pregnancy in which the blood pressure was less than 100/40. There were many patients operated on, who were poor risks, and the three deaths in this series could not be ascribed to the anesthetic. One death was due to a ruptured duodenal ulcer which developed two weeks subsequent to a subphrenic abscess. One death from cancer of the rectum occurred on the third day following a perineal resection of the rectum, and one death on the seventh day postoperative followed an extensive gastric resection.

TECHNIQUE

One and one-half hours before operation we administer morphine gr. $\frac{1}{4}$ and morphine gr. $\frac{1}{4}$ ten minutes before operation. This dosage is to be decreased or increased as indicated by the weight and temperament of the patient. The spinal region should be shaved as required. On the operating table the patient is painted with an antiseptic solution and washed off with alcohol. I prefer the sitting posture, with the spinal column bowed, not bent, though I do not see any particular objection to the recumbent posture. The main object is bowing of the spinal column.

A sterile towel is drawn across the crests of the ilia. The fourth lumbar interspace is on a line with the iliac crests. I usually use the second lumbar interspace, the second above the interspace in line with the iliac crests. The gloved thumb finds the third lumbar spine and with the thumb in position over the third lumbar spine the nail of the thumb is dipped into the space above and indented. Thus by experience will be found the right place to introduce the

needle. I use an ordinary Bier needle, 3 or 3½ inches and 18 gauge with a firm stylette in it. Into the marked second interspace the contents of a 1 c.c. ampoule of 1 per cent novocaine containing ephedrine is introduced, infiltrating the skin and deeper tissues. The needle is then introduced by steadily thrusting it through, being held firmly and guided into the midline. The passing of the needle into the spinal canal is felt as a sudden gentle release of pressure against the needle. The stylette is then withdrawn and from 4–8 c.c. of the spinal fluid are allowed to accumulate into an ampoule or medicine glass containing neocaine crystals.

Neocaine was used throughout in the 152 cases reported herein. The stylette is then reintroduced into the needle so that no spinal fluid is unnecessarily lost, while the crystals of neocaine are thoroughly dissolved in the withdrawn fluid by drawing in and expelling the contents with an ordinary Luer type glass syringe. When fully dissolved, which takes a few seconds, the fluid is drawn into the syringe, the air is expelled, the stylette is withdrawn from the needle and the syringe is attached to the needle. Draw a little of the spinal fluid into the syringe once or twice, to make sure that the needle has not changed position, and inject the fluid, withdrawing some spinal fluid into the syringe once or twice. The greater force used in injecting the fluid and the greater amount of the fluid used as a solvent will determine the height of the anesthesia. When injection is completed, withdraw the needle quickly and put the patient in 10 degree Trendelenburg position.

DOSAGE

I found it expedient to compute 0.001 gm. for each pound of body weight and to add to the computed amount from 0.03 gm.–0.05 gm., a larger dose being used for work on the gall bladder or gastric region. Given a patient weighing 150 lbs. in whom gall bladder or gastric surgery is indicated, I would use one ampoule of 0.15 gm. and

one ampoule of 0.05 gm. Given an individual weighing 150 lbs. for a lower abdominal or perineal procedure, I would use one ampoule of 0.12 gm. plus one ampoule of 0.05 gm. of neocaine. The highest dosage I have used (0.3 gm.) was in a woman weighing 268 lbs., without any outward results.

COMPLICATIONS DURING ANESTHESIA

Respiratory embarrassment, cyanosis, extreme drop of blood pressure, retching, vomiting are all best combatted by putting the patient in the extreme Trendelenburg position and instructing him to pant. Administration of CO₂ through a catheter is also instituted. Ephedrine, adrenalin or other stimulants are not necessary. In obese patients with cardiac enlargement the extreme Trendelenburg position should not be prolonged any more than necessary. The length of the anesthesia may vary from one to two hours and I often supplement the anesthesia by injecting under the lateral side of the rectus abdominis, outwardly, ½ per cent novocaine, to infiltrate the area of the lower intercostals. Likewise the peritoneum around the proposed incision is injected with ½ per cent novocaine. The local supplement is only resorted to where a prolonged procedure is necessary as in pyloroplasties, exploration of the biliary ducts, etc. When the peritoneum has been closed, CO₂ is given during closure of the fascia and skin. Deep respiration is thus induced. The patient is returned to bed on a stretcher in moderate Trendelenburg position and is left in bed in the same position for six hours. The patient is instructed to breathe deeply. Normal salt solution, 1000–2000 c.c., is given under the breasts or inside the thighs slowly: the solution must be warm. The patient is otherwise treated as any other surgical patient.

Extreme care must be exercised so that the hot water bottles do not come in direct contact with the skin of the lower extremities, for sensation may be slow in returning. The nursing care of these patients is less arduous as gas pains and ileus are rare,

some patients being alarmed at the absence of the traditional postoperative pains.

Catheterize as you would any other patient, as indicated. Narcotics are rarely needed after the first postoperative day.

Complications following spinal anesthesia have been very minor. Occasionally a patient complains of a headache, which can usually be controlled by an ice bag. There have been no other complications in this series. There was a marked absence of postoperative vomiting. Many patients received liquids per mouth the first few hours postoperative.

SUMMARY AND CONCLUSION

One hundred fifty-two major surgical cases were operated upon under spinal anesthesia, neocaine being used, with the

simple technique described. Many cases were in the extreme stage. No fatality attributable to the anesthesia occurred.

Spinal anesthesia is a safe procedure, allowing the surgeon greater freedom of manipulation and conducive to less trauma, resulting in greater comfort to the patient and a smoother convalescence.

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OBSERVATIONS ON 100 OBSTETRICAL CASES WITH AVERTIN ANESTHESIA*

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FOR the past five years the attention of the obstetrical world has been directed more and more towards devising means of relieving the pain and suffering accompanying childbirth. For years there were no satisfactory means of relief from this nightmare except hypodermic morphine and a few whiffs of chloroform. The old twilight sleep was an attempt in that direction but was soon discarded. The use of etheroil as an analgesic became quite popular a few years ago, and with its advent many other drugs have been used with more or less satisfaction and certainly with definite improvement over the old methods.

In the summer of 1926 Willstaedter and Duisberg of Germany introduced avertin, to be used alone for rectal anesthesia or to be supplemented by other narcotics including morphine and ether. There has been much discussion as to its advantages and disadvantages, and there has been a preliminary report of the Council of the American Medical Association upon avertin.¹ They conclude their report with the decision not to admit the drug to new and non-official remedies until further studies have been made, until the contraindications have been satisfactorily established, until the technique has become more satisfactory and until the advertising had been revised to omit misleading statements. It is not the purpose of this paper to argue the advantages of avertin with either the Council or with any of the clinics where it has been used experimentally and reports either favorable or non-favorable made upon the subject. But in the short space allotted to me I wish to relate briefly

my personal experience with the drug as used in a series of 100 cases and compare its advantages with the other means of obstetrical anesthetics.

With the exception of two classes of patients, the cases in which I used avertin were taken in succession and not selected. These two exceptions were, first, those patients admitted to the ward who were already well advanced in labor and who did not know their pregnant weight, and were in such condition that we were unable to get them out of bed and weigh them, and therefore unable to determine the dosage; second, those cases who were ready for immediate delivery upon their admittance to the hospital.

Avertin is tribromethanol, a white crystalline substance, soluble in 30 parts of water at 40°C. The manufacturers are marketing avertin in the form of avertin fluid of which 1 c.c. contains 1 gm. of avertin dissolved in tertiary amyl alcohol. For basal anesthesia the average dose of avertin fluid, that is the 1 gm. of the drug in the tertiary amyl alcohol, is 0.10 c.c. for every kilogram of body weight and the manufacturers suggest that for obstetrical anesthesia an average dose of 0.06 c.c. for every kilogram of body weight be given. It has been my experience that this dosage produced no amnesia, and only a slight analgesia, and its effect lasted only about one-half hour; as a result of this observation I have gradually adjusted my dosage so that I give a basal anesthesia dose for 20 lbs. less than the pregnant weight.

When the dose is determined, distilled water sufficient to make a 2.5 per cent solution is heated to 40°C., a glass receptacle that can be tightly closed, with a

¹ J.A.M.A., 95: No. 19.

* Read before the Syracuse Academy of Medicine October 20, 1931.

capacity of 500 to 1000 c.c. being used. The dose of avertin fluid is then measured with a graduated cylinder or pipette and added to the water; the flask is then stoppered, inverted and shaken vigorously until all globules of avertin fluid have disappeared. The solution must not be allowed to cool, as cooling causes the precipitation of avertin in crystalline form and when this occurs the solution must be discarded. Just before injection we place 2 to 5 c.c. of the prepared avertin solution in a test tube and add 1 or 2 drops of a 1 to $\frac{1}{1000}$ aqueous congo red solution. A pure orange red color should develop; if a blue or violet color develops the solution must be discarded as it has become decomposed and hence is dangerous. This test is a reliable safeguard only if the solution has been prepared with distilled water, therefore ordinary tap water should never be employed. This solution of avertin, at body temperature, is injected into the rectum, usually with a bulb syringe attached to a male catheter. By this means if the patient has a contraction during the installation of the fluid, the fluid is forced back into the syringe, and when the contraction is passed can be reinjected into the rectum, thus avoiding loss of fluid.

It is my routine to administer avertin as soon as pains become at all annoying, regardless of the amount of dilatation. Within ten minutes after the administration of the solution, the patient is sound asleep. In at least 50 per cent of the cases uterine contractions continue unabated, they increase in force and frequency and become of a longer duration just as normally as in those cases where no anesthetic is administered. In the remaining 50 per cent there is a decrease in the frequency of the contractions but apparently no change in the force or duration, this decrease occurring more frequently when dilatation is less than three fingers at the time of the avertin injection. In these cases I then administer hypodermatically a small dose of thymophysin in accordance with the amount of decrease noted in the frequency

of contractions, and repeat this dose of thymophysin in ten minutes if necessary. This procedure has never failed to bring back the uterine contractions to the point where they were before avertin was administered.

The effects of avertin usually last from one to three hours, which is as a rule of sufficient length for the usual multipara to deliver herself. In primiparas where labors are long drawn out, it is often necessary to repeat the avertin injection. This I do without hesitancy, but not until the patient is definitely out from under the influence of the first dose. In very few instances we find that after the administration of the drug, although the patients are unconscious, they are exceedingly restless, tossing themselves from one side of the bed to the other, and must be constantly watched to keep them from falling to the floor. This condition has been controlled in every instance by the administration of $\frac{1}{6}$ grain of morphine hypodermically. When the patient is completely under the anesthetic there is a relaxation of the cervix and vaginal walls which permits labor to progress rapidly, and in my opinion decreases the duration of labor by at least 25 per cent; one multipara going from one finger's dilatation to delivery in twenty minutes after administration of avertin. I find in the majority of cases there is no need for an auxiliary anesthetic at the end of the second stage, except in those instances where the delivery of the child and the termination of the effect of the drug coincide; in such cases I use nitrous oxide and oxygen inhalations.

Regarding the baby; there has been no necessity in any one of the 100 cases to use any means whatsoever to start respiration, it has always been of good color, cried immediately and never caused anxiety on the part of the obstetrician. Lacerations and episiotomies have been markedly less, due, I think, to the complete relaxation obtained by this anesthesia. After delivery blood chemistry and urine examinations were done on 60 per cent of this series and

in no instance was an abnormal report received. The only annoying after-effect which seems to follow the administration of this anesthetic is intestinal gas, usually appearing about twelve hours after delivery, but which is easily controlled by a soda enema.

I think there are distinct advantages of this form of anesthesia over the others now in use, and these advantages are not only of my own observation but are also the observations of multiparas who have previously been delivered under etheroil and gas oxygen, and later delivered under avertin. There is an absence of nausea and fogged mentality following the use of the drug, there is a more complete analgesia

and just as much amnesia. The amount instilled into the rectum is much less than in etheroil and therefore easier to retain, and neither does it give the burning sensation complained of so frequently when the etheroil is used. There is greater feeling of relaxation and well being when the patient awakens, and much less shock after obstetrical operations.

The contraindications for the use of avertin as given by the manufacturers are: advanced pulmonary tuberculosis, severe organic disease of the liver and lesions of the rectum. Other less definite contraindications are serious diseases of the kidney, blood acidosis and grave cachexia.



ELECTRICITY IN MEDICINE ELECTROSURGERY*

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ELECTROSURGERY is the application of high frequency electric currents for the destruction and removal of diseased tissue or for cutting through normal tissue with diminished bleeding. Its development has been due to the gratuitous cooperative labors of a group of physicists and medical and surgical investigators, to all of whom acknowledgment is due. As one reviews the history of this technique, it becomes evident that advances were often simultaneous and quite independent in widely separated areas, making it difficult at times to assign priority in the construction of apparatuses and improvement in technique. I shall give briefly, therefore, a resumé of the outstanding steps in the rise of this new surgical modality.

Fundamentally, electrosurgery owes its inception to the construction of the Leyden jar by Musschenbrock of Leyden in 1746 and to the discovery of electromagnetic induction by Oersted in 1821. Henry in 1842 showed that Leyden jars discharged with oscillatory vibrations. Hertz demonstrated in 1884 that vibratory waves pass from a generator to a distant receiver without tangible electrical connections.

William J. Morton adapted the principles of these discoveries to medicine and reported his static induced current before the New York Academy of Medicine on March 3, 1881, published in the *Medical Record* of April 2 and 9, of that year. He used an oscillation frequency in the neighborhood of 100,000,000 per second and a low tension current with a soft agreeable effect and no shock and with or without muscular contractions as desired. Sir Oliver Lodge's investigations in 1888 confirmed Morton's work.

Biological effects of these electrical phenomena were further studied and reported by d'Arsonval of Paris¹ who found that high frequency currents of high tension could be passed through living tissue without pain or muscular contraction if the alternations exceeded 10,000 per second, the only physiological effects being an elevation in temperature associated with marked respiratory changes and an increased absorption of oxygen and elimination of carbon dioxide. The generator used consisted of two Leyden jars as condensers with a spark gap between them connected to a coil without an iron core, an autotransformer. Two years later, he introduced the Rhumkoff coil (induction coil)² as a source of power and passed the current through a helix of large wire with but few turns far apart, deriving a powerful current with a spark from 5 to 15 mm. long in air. Upon placing animals in the circuit between the electrodes, without any direct connection with them, he observed that they were subjected to an extremely strong induction that gave rise to great modification in the excitability of isolated nerves and muscles and no less interesting changes in vital functions.

Tesla, in December, 1891, published his additional arrangement enclosing d'Arsonval's course spiral in a fine wire coil of many turns which further stepped up the current.

P. Oudin working along similar lines in 1893 devised a resonator, or solenoid, of a capacity and self-induction determined

¹ Action physiologique des courants alternatifs. *Compt. rend. Soc. de biol.*, Paris, vol. 43, May, 1891.

² Production des courants de haute fréquence et de grande intensité; leurs effets physiologiques. *Compt. rend. Soc. de biol.*, Paris, vol. 45, Feb., 1893.

* Read before the New York Electrical Society, Dec. 16, 1931.

according to the capacity of the condensers, the external plates of which are connected, the one to one extremity of this solenoid, the other to a point of its elevation, variable according to the intensity of the effects to be obtained. To the free end of the solenoid is fixed the electrode with which the patient is acted upon.³

These currents were used for so-called medical diathermy; that is, temperature elevation of a part of the body within physiological limits. It remained for Joseph Riviere to demonstrate that by increasing the density of the current with a small electrode, destructive effects are obtained. He, following an accidental discovery, treated an indolent ulcer on the back of the hand of a musician by spraying it with a spark from d'Arsonval's apparatus. Under repeated treatments, the ulcer healed. Riviere then enlarged the field of usefulness and attracted the attention of the medical profession. Pozzi called his modification of the method "fulguration" and for many years this modality was employed in the treatment of accessible tumors. Beer of New York in 1908 first adapted fulguration to the destruction of bladder tumors through a cystoscope, thus opening new vistas.

Independent of these discoveries, Finley R. Cook, also of New York, while working with a static machine received a superficial burn from a spark which gave him the idea of destroying tumors. Consequently, he used it for the eradication of small skin tumors, such as warts and moles and acne pustules, infected tonsils and hemorrhoids. Not aware of the European advances, he reported his results in 1906 and 1907.⁴

All of this work was with a uniterminal application through a single electrode. E. Doyen, however, ventured further, making use of a biterminal connection of the d'Arsonval coil, one, the inactive

electrode a large metal plate beneath the patient, the other active and much smaller, concentrating the current and producing much higher temperatures, 500° to 600° C., with more powerful effects. With this current, Doyen was able to destroy cancerous tissue to a depth of 1 or 2 cm., using a flat disc electrode of 1 to 2 cm. in diameter, applied to the surface for several seconds or minutes as the case demanded.

It is to William L. Clark of Philadelphia that electrosurgery owes its progress in America. He took the then somewhat crude apparatuses and cumbersome technique employed to a limited extent in the treatment of small, superficial tumors and developed both the uniterminal and biterminal currents by increasing the amperage and therefore heat production for the destruction of large, deep-seated malignant disease. His currents were much smoother and of higher frequency, having been split up by the introduction of a multiple spark gap. Clark and his co-workers were also the first to study the biological effects under the microscope.⁵

During the past few years, a third form of electrosurgical current has become available and popularized by the high-sounding title "radio knife." De Forrest in 1908 first obtained a cutting current from the vacuum tube apparatus. He, Neill and Sternberg experimented on dogs, making fine, clean incisions with little bleeding. Eager to construct an instrument for wider therapeutic uses, de Forrest failed to attain his ambition because of lack of medical cooperation. Attempts were subsequently made in Germany by Cohen and Stoye, an apparatus consisting of transformer, spark gap, and d'Arsonval coil being used. Later, Clark experimented with a similar type of instrument and discarded it. George A. Wyeth, working in the Loomis Laboratory in New York, in the summer of 1923, constructed an apparatus producing a cutting current and then made practical

³ Report of the Special Committee on the Static Induced Current, American Electro-Therapeutic Association, September 27, 1900.

⁴ *New York Med. J. & Rec.*

⁵ Clark, W. L., Asnis, E. J., and Morgan, J. D. *Atlantic M. J.*, vol. 27, 1923.

use of his discovery. Wyeth soon published startling results, which, together with the extensive work of Clark, suddenly attracted the attention of the medical profession and stimulated the application of high frequency surgical currents in practically all fields of surgery. Manufacturers have been of the greatest importance in the development of efficient machines, low in price, and operating with comparative ease. To them we owe no little debt of gratitude for the elaborate research, both expensive and time-consuming.

The cutting current of Wyeth was easily controlled and very fine, allowing primary healing when desired, the thin layer of dehydrated tissue on either side of the incision being absorbed as the wound united. With these three available currents, tumors are destroyed in situ, either by desiccation or coagulation and removed with the cutting current. Wyeth's machine, combining all three currents in one cabinet, was expensive, and in an effort to economize the manufacturers produced apparatuses wherein the radio tubes were replaced by spark gap oscillating circuits modelled after those mentioned above. Unwittingly, a great advance was made, for with the spark gap instrument a tremendous amount of heat is generated simultaneously while cutting, the lethal temperature penetrating to a depth of 1 or 2 mm. on each side, reducing the two-step operation of first destruction and then excision to a single one of destruction during excision as pointed out by Groff.⁶ This is the most valuable current for the treatment of large, ulcerated tumors, or, by applying the current through a loop, otherwise inaccessible tumors are removed piecemeal with safety. By varying the size and shape of electrodes and by electrifying certain surgical instruments, a great range of adaptability is attained.

To recapitulate then: our present-day apparatuses are of two main types referred

to as the spark gap generator or the radio tube generator.

The first requirement in a spark gap generator is an efficient step up transformer, usually having the primary and secondary coils wound on opposite legs of a laminated sheet iron core in the form of a hollow square. Sometimes these transformers are immersed in oil for cooling purposes. A choke coil control, between the primary of the transformer and the line current, regulates the amount of current flowing into the transformer. From the secondary of the transformer, the current passes through the oscillating circuit, consisting of Leyden jars or plate condensers, according to the design of the apparatus, a multiple spark gap, and an inductance coil. In medical literature the inductance coil having a biterminal connection with the patient is named after its designer d'Arsonval and that coil having a uniterminal connection, called Oudin, after its inventor. From such an apparatus, damped high-frequency currents are obtained, the oscillations, spark frequency, voltage, and amperage being under accurate control.

Current variations are obtainable from the tiniest, almost invisible spark for the dehydration of minute tumors about the eye to flashing sparks for blasting out large, deep-seated growths. By approximating the spark gap and keeping down the voltage, tissue is severed as readily as with the sharpest scalpel, with the tremendous advantage of sealing capillary blood vessels and lymphatic channels, limiting dissemination of the disease. Strengthening the current drives the heat deeper with destruction of 1 or 2 mm. of tissue on each side of the incision. For coagulation destruction only, without the cutting property, still stronger currents are obtained, literally cooking to a depth of 8 to 10 mm. Larger blood vessels are sealed with such currents, the thick coagulum preventing primary union, which is not essential and often impossible with large tumor masses that leave disfiguring

⁶ Suttan, H. *Med. Herald and Physictherapist*, Aug., 1929.

defects. The chief aim is to eradicate all malignant cells and cover the wound with a sterile coagulum preventing implantation or dissemination. At best, in such instances, healing is by granulation and subsequent scarring, plastic operations later repairing the deformity.

The radio tube generator is useful and important by reason of its compactness and ease of operation; for an equal amount of power, it being about one-third the weight of the spark gap apparatus. Many of the functions of the spark gap instrument are reproducible by the tube generator, especially cutting, with the added advantage of a greater constancy in the primary union, when desired in clean cases, as the operating frequency is always definite and the heat penetration of the undamped current more easily controlled.

Heavy coagulation currents are, however, not usually so readily and satisfactorily produced with tube generators as at present constructed: the smooth deep-heating properties of the well-balanced spark gap being replaced by a flame-like long spark obscuring vision, charring tissues quickly and preventing deep coagulation. Particularly is this true when the effort is made to combine coagulating with cutting properties called for in removing large ulcerative growths about the face and oral cavity. Recent advances, however, indicate that these difficulties are being overcome.

The construction of the usual form of vacuum electrosurgical generator is similar to that of a radio transmitter, the tubes being connected in full wave rectification, the second tube working during the idle half-cycle of the first.

The passage of concentrated high frequency currents through living or dead tissues develops an intense heat within them, causing well-defined gross and microscopic changes enhanced perhaps by a yet unknown electrical or magnetic biochemical phenomenon. In contradistinction to all previously used forms of heat therapy, the destructive effects are gener-

ated within the tissues themselves, which form a part of the circuit traversed by the current. It is, therefore, evident that the fundamental principles of our electrosurgical procedures are utterly diverse and never-to-be-confused with the various electric cauteries.

The biophysical reactions of the passage of an electric current through tissue are in general like the physical changes when the current passes through solutions, being electrolytic rather than metallic: that is, the transfer of electricity is accompanied by the transfer of charged matter. This is a complicated process in tissues as compared with solutions, for protoplasm is not a molecular chaos, as in simple solutions, but the molecules are held more or less fixed in the heterogeneous polyphase colloid: its ions not being free to migrate in every potential gradient. Migration is hampered at the colloidal interphases, especially at such bounding interphases as separate the nucleus from the cytoplasm and those which form the cell walls. Under the influence of a potential gradient, these semipermeable membranes become polarized and the ions of adjacent phases become concentrated at these membranes, the molecules taking on new orientations in the electrical field with consequent disturbance of the protoplasmic pattern. Because the accompanying electrification does not support the continued existence of the protoplasm, the electric current is lethal. This lethal effect, due to polarization, may be avoided, if we do not permit the current to flow long enough to bring about the molecular disarrangement with the accompanying electrification. Death of the tissue is prevented if, instead of interrupting the current after it has been flowing a short period of time, its direction is changed, thus reversing the potential gradient in the protoplasm and, correspondingly, the migrations and orientations. If this frequency of alternation is high enough, sufficient current may be passed through the tissues, so that no effect other than heating will appear. The

rise in temperature depends entirely upon the density of the current, the current-strength, and the time of application. When large pad electrodes are used, the current is disseminated throughout part of the body, for instance an extremity or joint or even the entire body, raising the temperature within physiological limits and with therapeutic effect. If one of the electrodes is made small enough to concentrate the current sufficiently, temperatures are reached far above that tolerated by living tissue. It is this destructive characteristic which is utilized in electrosurgery. Under the action of such high frequency currents as described, tissues are dehydrated to a white powder, easily brushed away, or coagulated in their own boiling juices to a white clot, and they are further heated, if desired, until converted into a dense, dry, contracted homogeneous mass, which is removed with no fear of dissemination of disease. Too prolonged application of the current beyond the dried out coagulum will cause oxidation and carbonization, the carbon then becoming an insulator against further penetration of the current and therefore heat, a condition not comparable with good electrosurgical technique.

Time will not permit a complete discussion of the complex biophysical and electrical phenomena of electrosurgery. A few words, however, are timely to describe cutting effects.

With the usual amount of current impressed upon the operating electrode, arcing and sparking occur between it and the tissues, the depth of destruction depending upon the amount of current employed. The electrode and the tissues act as plates of a condenser and the tissue changes produced are profoundly influenced by the characteristics of the wave train. If the wave trains are markedly damped, dehydration and coagulation result, but undamped wave trains of sufficiently high density sever tissue as cleanly as a sharp scalpel; rapid movement of the electrode keeps the destruction at a

minimum along the cut surfaces. Increasing the amount of damping together with the current strength adds to the coagulation and dehydration of the cut surfaces. This is the real value of the spark gap generators for vascular tissues are severed without loss of blood except from large arteries. These are quickly caught with a hemostatic clamp through which the current is then passed, sealing the vessel within its grasp.

In our surgical terminology three names are used to designate three separate currents and their respective tissue alterations. The uniterminal application of a spark gap damped current from Oudin's resonator is called "electrodesiccation," first described by Clark, Asnis, and Morgan.⁷ The biterminal connection of the patient and d'Arsonval coil with its heavier effects was termed electrocoagulation by Doyen.⁸ Electro-cutting is performed chiefly with a biterminal connection from properly balanced spark gap or radio tube apparatuses, although it is possible to sever tissue with a uniterminal current when intense enough.

Electrodesiccation, as the name implies, is the dehydration of living tissues by a moderate heat usually induced by the passage of a uniterminal high frequency current. As the water evaporates from the cells, the tissues assume a blanched, arid appearance, and small moles, warts, corns and other skin blemishes are brushed off in a white dry flake or powder, leaving a considerably toughened, dry, white surface. Under the microscope, the tumor cells are seen drawn out and shrunken with elongate nuclei, uniformly taking a heavy blue hematoxylin stain; they are spindle-shaped and preserve their cellular characteristics with walls and nuclei easily discernible. The stroma cells are likewise elongated and shriveled with nuclei more compact.

Electrocoagulation is a more advanced destruction, usually accomplished by a

⁷ *Idem; Radiology*, 11: 4, 1924.

⁸ *Surgical Therapeutics and Operative Technique*, 1917, Vol. 1.

strong biterminal current generating higher degrees of heat and coagulating tissue proteins into a homogeneous material which grossly assumes a white parboiled appearance in contradistinction to the carbonization of the hot cautery instruments. Owing to the intense heat, a truly dry stage is not seen until the treatment is prolonged. The tissues first boil in their own fluids and surrounding lymph, quickly forming a white coagulum. When much connective tissue is present, the coagulum is tough and removable only with the cutting current or instrument; if epithelial cells predominate, the coagulum is granular and friable and yields readily to the abrasion of a curet.

Microscopically the changes are progressively more marked than after desiccation, varying from dried shriveled cells all the way to a uniformly granular debris of stroma and tumor cells. With the usual application, the structure of the stroma cells tends to remain faintly outlined, with scattered nuclei, appearing shrunken and elongated, in the hyalinized mass. Other cells suffer more complete destruction and are partially exploded by the steam formed within them, obliterating their identity. Those receiving most heat are completely coagulated in a uniformly staining residuum.

A microscopic examination of the cut edge reveals two distinct layers: the first is a thin line of finely divided particles of carbon formed by the breaking down of the large protein molecule; back of this lies the second broader desiccated or coagulated layer, with sealed lymphatics and capillaries. When primary union is desired in clean cases lighter currents are employed, and electrodesiccation is more in evidence; but when excising massive growths, with heavier currents, coagulation occurs along the edge of the incision for considerable depth.

The healing of electrosurgical wounds depends entirely upon the type and strength of current and the use to which it is put. In ordinary surgical procedures,

such as gall-bladder operations, breast amputations, appendectomies, etc., the cutting current has been given a trial substitution for the scalpel in an effort to determine any real value over the sharp knife. With carefully chosen currents, excellent primary union is obtained and the operation is rendered much less bloodless. It is claimed by many that the heat sterilizes the skin edges, preventing wound infections, hastening healing. However, with the difficulties attendant in securing the proper current and the added complexity of technique, it seems likely that electrosurgery will never replace the scalpel in such operations except perhaps in breast amputations. Some observers have had great difficulty with wound healing, probably due to the use of unnecessarily heavy currents.

Small skin blemishes dried up by the current are left as a protecting sterile coagulum to separate in from one to three weeks, depending upon the size, when usually epithelialization has taken place beneath the smaller one; with larger involvements, the wounds heal by granulation after separation of the scab. With massive malignant tumors it goes without saying that a long period is necessary for healing. At operation the wounds are left covered with a sterile coagulum 1 or 2 mm. in thickness. Under proper aseptic and antiseptic treatments, this coagulum gradually sloughs away, leaving a healthy, vascular, granulating surface, upon which, if occasion demands, many small skin grafts can be planted. In other instances, healing is by scarring and epithelialization under careful surgical dressings, and at a suitable time repair operations are performed.

A characteristic of electrosurgical wounds is the soft pliable cicatrix, lessening disfigurement and making plastic operations easier. This is of special value about the eye where dense contractures, from other forms of therapy, distort the lid, likewise in the mouth flexibility of the tongue and cheek is necessary.

The field of electrosurgery is enlarging by leaps and bounds. From its meager beginning in the destruction of small, superficial skin diseases, it has reached out into practically all surgical specialties.

In selected cases where surgical operations are contraindicated, tonsils are destroyed in one or several sittings, as necessary in the given case, with no bleeding and very little discomfort. Hemorrhoids are also treated with similarly good results.

Following Clark's lead, we are now able to remove massive malignant disease, involving the eye and orbit, the nose, tongue, floor and roof of the mouth, even when there is extension to the jaw bones. Cancer is no respecter of tissue and invades bone, requiring special technique for its resection. With electrosurgery, all organic matter in bone is destroyed, the dead bone then being removed with impunity. Recently I devised an electrosurgical rongeur, which cooks and sterilizes the bone as it is bitten off. During the course of the electrosurgical operations, large vessels are encountered. These require special attention, either by the direct application of a blunt electrode, simultaneously collapsing the vessel and sealing the walls together, or by a hemostatic clamp applied and the current passed down this clamp to seal the vessel within its grasp, as suggested by the author several years ago.

Cancer of the nasal sinuses, formerly treated by mutilating operations with poor results, can now be cleaned out with electrosurgery, making way for the application of radium to destroy any lingering disease, which might lurk in these inaccessible places. Usually the antrum is approached by reflecting a flap of skin from the face and the massive tumor taken out with an electrified wire loop or curet. Approaching it in this fashion, all ramifications are outlined and sterilized with this remarkable current.

Large tumor masses in the neck, formerly inoperable, are now removed by wide dissection, using a heavy cutting current.

In these operations large tributary vessels should be previously ligated to guard against hemorrhage.

Cancer of the bladder and prostate gland, always serious problems, are much more rationally treated by electrosurgery alone or in combination with other forms of treatment. In small bladder tumors, the method first described by Edwin Beer in 1908 is still, with some modification, employed. Through an operating cystoscope he treated and eradicated papillary growths, applying the current on a long, insulated instrument. More extensive involvements require opening of the bladder and destruction and removal with the current applied on suitable forms of electrodes, particularly a wire loop with which the growth can be scooped out without bleeding. The base is then thoroughly treated by the application of radium directly through the open wound. Obstruction at the neck of the bladder is now relieved by specially devised instruments for resection with electrosurgery. This can be done under local or spinal anesthesia with a minimum of incapacitation.

Certain vascular organs, as the liver, spleen and kidneys, are now approachable with this blood-controlling surgical adjunct. The author, associated with Pierce and Scott, has experimented on animals, discovering the proper type of current for incisions in these organs. Practical application is now being made in the resection of diseased portions of the kidney or opening it for the removal of stones and tumors. I recently operated on a human liver with marked diminution in the amount of blood lost.

Tumors in the abdomen not infrequently attach themselves so densely to the intestines that resection endangers the intestinal wall, risking the life of the patient. We can now dissect these from the loops of bowel with a limited amount of bleeding and great benefit to the patient. Investigative work is continuing to make electrosurgical currents more adaptable to gastrointestinal surgery.

Chest surgeons following Jacobus and others working through a telescopic instrument, release dense adhesions, attaching the lung to the chest wall, collapsing tuberculous lungs for rest and healing.

Under the advancing leadership of Harvey Cushing brain tumors are now removed with increased facility. This method brought such startling results that Cushing recalled patients, whom he had formerly given up as hopeless, shrank the tumor with the coagulating current, and removed it; others were scalloped out with an electrosurgical loop, collapsing the walls, reducing its size, and permitting withdrawal through the small exposures

of skull and brain operations. I have had similar experiences operating with Charles Bagley of Baltimore. We were able to reduce the size of several of these distressingly difficult tumors and remove them, a feat which would have been absolutely impossible in former years.

Time does not permit elucidation of the difficulties and refinements of the technique of electrosurgery, all of which are acquired by diligence and experience. An adequate surgical training is a prerequisite to the adoption of electrosurgery. It little behooves the novice to take up such a powerful weapon, dangerous in the hands of the unskilled.



RESULTS OF A NEW METHOD FOR THE REPAIR OF INGUINAL HERNIA*

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IN 1929 Schmieden¹ described a new method for the repair of inguinal hernia, not as a substitute for the Bassini

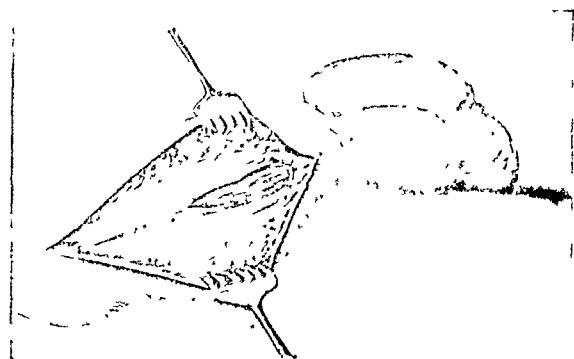


FIG. 1. Incision and exposure of cord. (From Schmieden).

method, but rather as an aid in selected cases. The principle of Schmieden's method is embodied in a scheme of transplanting the cord to a newly made internal inguinal ring in the oblique and transversalis muscles at the outer edge of the rectus. This transplantation, made possible only by raising the testicle out of the scrotum, allows a complete and solid closure of the entire inguinal floor. Many recurrences appear at the site of the internal ring, and to eliminate these this new operation was devised. This report is concerned with a follow-up study of 102 cases operated upon by this technique between January, 1929 and December, 1930 in the Frankfort Clinic.

The technique of the operation briefly is as follows:

The usual skin incision for inguinal hernia is made, and the external aponeurosis exposed. It is cut parallel with its fibers over the cord (Fig. 1), the incision

being extended well above the internal ring. The medial leaf is caught with two forceps and retracted upward to expose the underlying muscles. The cord is then freed from its bed and the testicle slowly drawn from the scrotum. All bleeders, even the tiniest, are carefully tied off as they are exposed. The gubernaculum of Hunter, usually present as a well-defined fibrous strand at the inferior pole of the testicle, is doubly tied and cut, the ligatures being left long to permit repair at the close of the operation. A wet compress is placed in the scrotum. Raising the testicle out of the scrotum is an essential step in the operation, and, although a somewhat radical procedure, permits more careful and complete separation of the sac and its ligation high in the inguinal canal. Furthermore, it makes possible a more thorough inspection of the inguinal triangle for direct hernia, and an unobstructed view while making the repair.

The sac is dealt with in the usual manner.

A 2 to 3 cm. strip in the internal oblique and transversalis muscles is next separated from the external surface of the peritoneum by dull dissection. This muscle strip is raised with a dull retractor, and about 2 cm. above its lower border and at the edge of the rectus sheath an opening large enough to allow the testicle to pass through is made in the muscle by separating the fibers bluntly (Fig. 2). The opening is maintained with two single blade retractors, and the testicle drawn through from below upward by grasping the gubernaculum with an artery forceps. The testicle is then wrapped in compresses wet with salt solution, and laid out of the operating field while the repair is effected.

¹ Schmieden. *Arch. f. klin. Chir.*, 157: 617, 1929.

* From the Surgical Clinic of the University of Frankfort-on-the-Main, Germany, Prof. V. Schmieden, Dir. Submitted for publication July 10, 1931.

The first suture is put in the upper angle of the wound, and closes snugly the former region of the internal ring. The second

RESULTS

During the years 1929 and 1930, 102 patients were operated upon by the fore-

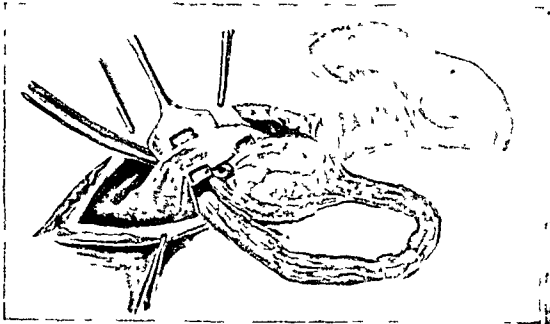


FIG. 2. A 2 cm. strip of transversalis and internus muscles has been raised. Testicle is being drawn through newly formed internal ring. (From Schmieden.)

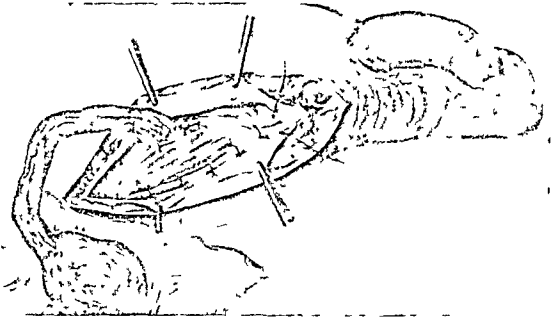


FIG. 3. Inguinal floor has been repaired throughout its entire length. Sheath of rectus has been sutured to periosteum of pecten pubis. (From Schmieden.)

suture is placed in the lower angle of the wound, and anchors firmly the edge of the rectus sheath to the periosteum of the pecten pubis. One or two stitches in this area are very important to remove all tension from the sutures of the transversalis and internal oblique muscles to Poupart's ligament (Fig. 3). The entire floor of the inguinal triangle is now completely closed. A stitch or two closes the muscle slit snugly but not tightly about the cord. The severed ends of the gubernaculum are brought together, and the testicle replaced in the scrotum, care being exercised not to twist the cord. Figure 2 illustrates how the newly formed internal ring lies beneath the upper leaf of the external oblique aponeurosis. The external ring is formed in the lower angle of the wound; the aponeurosis of the external oblique muscle being simply sewed edge to edge or overlapped according to the method of Girard. The loose fatty and connective tissue at the base of the scrotum and the subcutaneous tissue are closed with fine catgut sutures; the skin with silk.

The wound is dressed and sufficient padding placed over it to maintain pressure. The scrotum is well supported by a cotton pad bandaged firmly into position. The routine postoperative care is exercised.

going technique, including 6 cases with bilateral herniae, making a total of 108 operations. Of these 2 were sliding, 3 incarcerated, and 5 recurrent. In 16 patients with bilateral herniae the smaller was repaired according to the Bassini method.

In Table 1 a résumé of the cases and the important facts concerning operation and immediate postoperative findings are given.

Table II shows graphically the results of our follow-up examinations in 66 cases and replies to questionnaires in 22 cases.

There was no mortality. Three cases developed postoperative bronchitis, one pneumonia, one pleuritis, and 3 thrombosis in the femoral veins, 2 of which had subsequent inconsequential pulmonary emboli.

Ether anesthesia was used for 50 cases, usually with avertin as a base. Spinal anesthesia was given in 31 cases without any untoward results. Local anesthesia was used for the early cases, 27 in all, but was later practically abandoned when it was observed that hematoma developed frequently following its use; due most likely to the constricting action of adrenalin on small vessels which later dilated and bled.

Six wound infections occurred, 4 of which were stitch abscesses. One patient put a piece of wire into the wound and produced

a fistula which healed promptly when the wire was discovered and removed. The sixth case of infection associated with a hematoma formed an abscess beneath the skin and required incision. None of the cases with infection developed recurrences.

The position and condition of the testicle on the operated side were very carefully observed. In 8 instances it lay from 1 to 2 cm. higher than the opposite one, but this had not been detected by the patient. The testicle lay high at the base of the scrotum

TABLE I

Age in Years	Number of Operations	Normal Healing	Hematoma	Infection	Anesthesia			Days in Hospital	Weeks off Duty
					Ether	Spinal	Local		
20	6	6			3		3	15	5.8
20-30	30	22	8		18	2	10	16.3	6.4
30-40	20	15	2	2	12	3	5	17	6.0
40-50	17	14	2	1	6	7	4	20.6	7.0
50-60	22	19	3	2	8	12	2	17	6.1
Over 60	13	9	2	1	3	7	3	19.4	7.0
Totals	108	85	17	6	50	31	27	17.5	6.3

TABLE II

Age in Years	Examined	Reported by Letter	Total	Atrophy of Testicle	Testicle High in Scrotum	Pain in Scar	Recurrences	Observation Time	
								3-12 Mos.	12-27 Mos.
<20	6		6			1		2	4
20-30	17	8	25	1	6	6		6	19
30-40	5	6	11					2	9
40-50	15	2	17	3	5	1	3	6	11
50-60	16	3	19			3	3	8	11
Over 60	7	3	10		1	1		4	6
Totals	66	22	88	4	12	12	6(6.8%)	28	60

Hematoma developed in 17 cases, varying in degree from discoloration and slight swelling to distention of the scrotum. A number of times puncture was made without obtaining blood. The hematomata were not caused by frank hemorrhage but by oozing of blood into the easily distended tissues. They were treated by support and dry heat, and had in most cases absorbed by the time of discharge from the hospital.

in 4 patients and was associated with moderate atrophy, the testicle being approximately one-half the size of the opposite one.

Pain in the scar was complained of by 12 patients, and described as a twinge in the inguinal region following violent exercise, and in two instances associated with sexual intercourse.

Disturbances of sensation associated with a weakness of the abdominal wall

(pseudoherniae) in the region immediately above the former internal ring were found in 3 patients and ascribed to errors in the technique of dealing with the nerves.

Recurrences were found in 6 of 88 cases, 66 examined personally and 22 reached by letter, or 6.8 per cent. The observation time of the majority of patients was between one and two years. All of the recurrences were in patients between forty and sixty years of age, and developed within the first postoperative year. This fact of early recurrence agrees with the observations of others. Although there is no guarantee that other recurrences will not appear we believe that a reasonably fair picture is presented. A short review of the important facts in the histories of the recurrent cases follows.

REPORT OF CASES

CASE I. Engineer, aged forty-two, with a right-sided inguinal hernia for two years supported by a truss. Irreducible at time of admission. Operation under local anesthesia. Normal postoperative course. At follow-up examination a hernial opening 1 cm. in diameter was found in the middle of the scar; a small direct hernia most likely due to a cutting through of one of the muscle to ligament sutures.

CASE II. Cafe proprietor, aged fifty-one, much overweight, with right-sided direct hernia for two years. Operation: Avertin ether anesthesia. Fat-streaked musculature, weak fascia. Primary wound healing, slight scrotal hematoma, light attack of bronchopneumonia. Re-examination: In lower angle of the scar a large recurrence which developed almost immediately after discharge from the hospital. Direct hernia.

CASE III. Workman, aged forty-three, with large right-sided inguinal hernia for thirty years, umbilical hernia and varicocele. Operation: Avertin ether anesthesia. Both direct and indirect herniae were found. Usual technique employed. Normal healing. Patient returned to work four weeks after discharge from hospital. Follow-up examination: Recurrence of direct hernia in lower angle of scar. It appeared almost immediately after returning to work.

CASE IV. Turner, aged fifty-two, with large right-sided irreducible hernia, chronic bronchitis, emphysema and dyspnea. Immediate operation under local anesthesia. Normal healing except for small hematoma. Follow-up examination ten months after operation: Small hernia in lower angle of scar which will admit only the tip of the finger. No bulge. There was considerable question whether this was not a small hernia. It is listed as one of our recurrences.

CASE V. Laborer, aged forty-six, with recurrent hernia operated upon six weeks previously elsewhere with recurrence after four weeks. Examination revealed two bulges, one apparently below the inguinal ligament. Diagnosis: inguinal and femoral herniae. Operation under spinal anesthesia was difficult because of disturbed anatomical relations and scar tissue. No femoral hernia found. Follow-up examination six months postoperative: Complaint of pain in lower angle of scar. No visible hernia. After jumping, straining and coughing a slight protrusion could be felt which upon pressure disappeared with a gurgling sensation to the palpating finger. No hernial opening was demonstrable. It is likely that this was a femoral hernia missed at operation. It is included as one of our recurrences.

CASE VI. Plumber, aged fifty-two, with scrotal hernia for two years, incarcerated a few hours. Operation: Viable bowel replaced, cord edematous and thick. Follow-up examination: Patient had returned to work fourteen days after discharge. Recurrence in upper angle of scar. Re-operation: Hernia through newly made internal ring in the conjoined muscles. The swollen testicle necessitating a large slit in the muscles may have been a factor in this case. The muscle fibers below the cord were unchanged. The sac was removed and the muscle slit closed. No further trouble to date, two months after second operation.

DISCUSSION

In a consideration of our percentage of recurrence, 6.8, it is essential to bear in mind that this technique has been used only in adult males with a large, a recurrent, or a sliding hernia. During this same period of time many children as well as

adults were operated upon by the standard Bassini technique.

Statistical reports of recurrences are fewer than descriptions of new operations and modifications of technique. The percentage of recurrent herniae reported depends more upon the investigator, the age of the patient, and the type of hernia dealt with than upon the operator. B. L. Coley¹ reports 8.7 per cent recurrence of indirect inguinal hernia in adult males operated upon at the Hospital for Ruptured and Crippled in New York. Coley and Hogue² report 0.57 per cent recurrence or less than 1 per cent from the same hospital. The difference lies in the simple fact that the latter statistics include many male children in whom recurrence is practically

unknown. Both reports are based on careful follow-up work. If 8.7 per cent of indirect inguinal hernia recur in a hospital where thousands of cases are operated upon by a few skilled surgeons the average percentage is undoubtedly higher.

The method here described is recommended for the adult male with an indirect inguinal hernia with a large internal ring, and for sliding hernia. Its advantage in the latter is apparent. After replacing the bowel and dealing with the partial sac, the internal ring can be closed solidly and reenforced with fascia lata if desired.

In this series there has been no recurrence at the site of the former ring. The use of living fascia from the rectus or thigh to support the region medial to the deep epigastric artery will be tried in an effort to lessen the incidence of subsequent direct herniae.

¹ Coley, B. L. *Ann. Surg.*, 80: 242, 1924.

² Coley, W. B., and Hogue. *Ann. Surg.*, 68: 255, 1918.



ARTERIOVENOUS ANEURYSM OF THYROID VESSELS*

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IN spite of the frequency of operations upon the thyroid gland situated in a region where so many large vessels are in juxtaposition, to our knowledge only one case of arteriovenous aneurysm has been reported.¹ We have had another such case:

A white female, aged twenty-nine, was admitted to the Cleveland City Hospital February 2, 1931 with a complaint of edema of the legs, shortness of breath, palpitation, cough, and nervousness. She stated that she had had "heart trouble" for ten years. At the age of thirteen she had a goiter but it was not until some years later that the symptoms of palpitation, nervousness, and loss of weight became pronounced. In 1927 a thyroidectomy was done with an improvement in her general health and nervousness. One year ago she began to have a severe cough. In spite of negative x-rays and sputum, she was sent to a tuberculosis sanitarium where she remained nine months. During this time her chief complaints were nervousness, palpitation, and unproductive cough.

Physical examination showed a poorly nourished and developed woman, not acutely ill. She was very apprehensive. On the left side of the neck in the region of the upper border of the thyroid cartilage there was a marked pulsation. Over this pulsating area there was a palpable thrill which persisted during the whole cardiac cycle with systolic accentuation. A loud continuous bruit was heard over this area.

The rest of the physical examination was negative. Electrocardiogram showed a normal mechanism. Fluoroscopic examination of the heart showed the left ventricle slightly globular. Pulse varied from 80 to 90. Blood pressure 114/80. After compression of the pulsating area, it rose to 130/95.

Operation March 14, 1931. Local anesthesia. A transverse incision was made on the left

side of the neck at the level of the upper border of the thyroid cartilage.

There was a pulsating mass in the upper

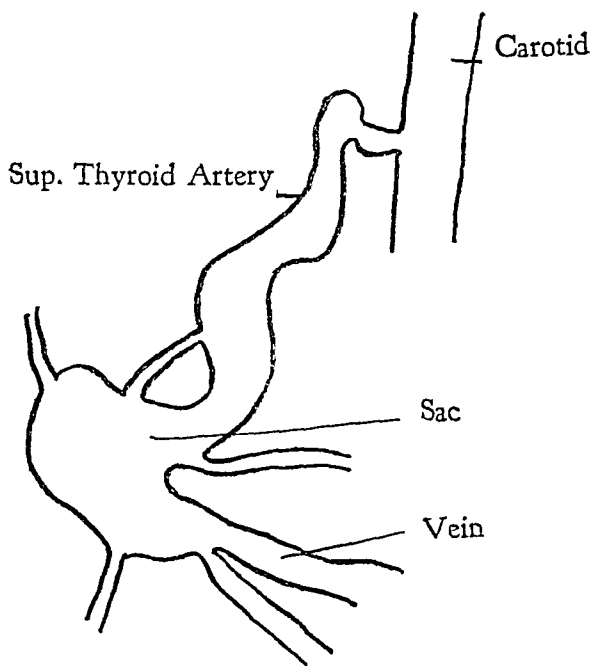


FIG. 1.

angle of the wound which proved to be an elongated, dilated, tortuous superior thyroid artery. The artery, becoming larger in size, continued into an irregular sac over the upper part of which there was a pulsation and a thrill. The pulsation was lost at the lower part of the sac but the thrill persisted. At the lower end the sac divided into several large tributaries which seemed to empty into the internal jugular vein. From the medial side smaller vessels emptied into the sac.

The superior thyroid artery was ligated close to the carotid. All collateral vessels were ligated, and the entire mass excised.

Following the operation, the cough and shortness of breath subsided, although the general nervousness persists.

¹ Mora, J. M. *Surg. Gynec. Obst.*, 48: 123, 1929.

* From the Departments of Medicine and Surgery, Western Reserve Medical School, City Hospital, Cleveland.
Submitted for publication August 20, 1931.

VASCULAR ORIGIN OF CONGENITAL TORTICOLLIS

CASE REPORT*

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THE final lesions in a long-standing case of secondary congenital torticollis are fibrosis and contracture in the sternocleidomastoid muscle. The deformities of the face and skull are the natural mechanical sequelae of the primary shortening of the sternocleidomastoid muscle. This paper presents a study of the anatomy and physiology of this muscle, and of the pathological changes encountered in an early case. Certain features deserve especial attention.

The sternocleidomastoid muscle arises from the sternum and clavicle by two heads. The medial head is a rounded fasciculus arising from the upper part of the anterior surface of the manubrium sterni. The clavicular head arises from the superior border and anterior surface of the medial third of the clavicle. The two heads are separated at their origins by a triangular space, but gradually fuse into a thick rounded muscle which is inserted by a strong tendon into the lateral surface of the mastoid process and into the lateral half of the superior nuchal line of the occipital bone. The sternocleidomastoid muscle is supplied by the eleventh cranial nerve and the second and third cervical nerves. The muscle is derived from three embryonic metameres and retains its arterial and venous blood supply as based upon the primary segmentation. The upper mastoid portion of the muscle is supplied by the superior sternomastoid artery which is a branch of the occipital artery. The venous return penetrates the deep aspect of the muscle to join the large veins. The sternal head of the muscle is supplied by the middle sternomastoid artery which takes origin from the superior thyroid artery. This

artery follows along the posterior border of the sternal head, sending numerous branches into the head. The venous return parallels the artery. The clavicular head is supplied by the inferior sternomastoid artery, a branch from the thyrocervical trunk. The venous return may parallel the artery or return directly to the external jugular vein.

Nové-Josserand and Viannay¹ studied the circulation in the sternocleidomastoid of the stillborn fetus and demonstrated that the three systems of blood supply are independent and not connected by anastomosing channels. They further showed that extreme rotation of the head caused the tense sternocleidomastoid to compress the middle and inferior sternomastoid arteries so that they could not be injected. Middleton¹ has advanced the theory that the important factor is not arterial, but venous obstruction which might easily occur at parturition.

There are certain statistical correlations between the incidence of torticollis and the type of labor undergone. Plass³ analyzed over 5000 vertex presentations at the Johns Hopkins Hospital and found 64 per cent left-sided positions and 36 per cent right-sided positions. Zweifel⁴ in over 9000 vertex presentations found 71 per cent left-sided and 29 per cent right-sided positions. As the greater portion of the posterior positions will either rotate anteriorly or be rotated by the obstetrician, it means that, following the normal mechanism of labor, almost twice as many infants will be subjected to a pronounced torsion of the head to the left, followed by hyperextension of the neck as the body descends and the occiput snubs beneath the symphysis, as

* Submitted for publication September 23, 1931.

will be subjected to the strains incident upon the homologous position. As the normal mechanism for delivery of a left position tends to throw increased strain upon the right sternocleidomastoid, it is of interest to observe Hutter's⁵ statistics which show a slight preponderance of right-sided torticollis. He has collected a series of 691 cases, 56.4 per cent of which were on the right. These figures are affected by the somewhat high incidence of torticollis following delivery from other positions than the vertex position. Of Middleton's² series of 64 cases of torticollis, 43 were first children and hence were probably subjected to a relatively prolonged second stage of labor. Of the remaining 21, 16 were difficult prolonged labors, cross-births or breech presentations. In a series of 54 cases of Erb's paralysis, a condition which is known to be associated with protracted labor and difficult delivery, 20 per cent exhibited a sternomastoid tumor.

In a large number of cases of torticollis there is a history of the sudden appearance of a sternomastoid tumor at about the end of the first month of life in an infant previously considered entirely normal. In a portion of these cases the tumor may be concealed by the short neck of the infant, but in many cases it seems definitely established that there is no onset of signs before the end of the first month of life.

Comparatively few operations or pathological studies have been reported for infants of one to two months. Von Lackum⁶ has reported 3 cases which are of especial interest; 1 was a child five weeks of age, and the other 2 were eight weeks of age. In only 1 of these cases was there a history of a difficult breech delivery. In the first case a sternomastoid tumor was noticed soon after birth, in the other two it was first noticed at the end of one month. In all cases the tumor mass was immediately excised, and subsequent follow-up examination after an interval of months revealed a good anatomical and functional result. The pathological picture in these cases was

substantially that which is to be more fully described later.

The essential pathological change seen in



FIG. 1. Old thrombosis of two veins and perivascular round cell infiltration. Hematoxylin and eosin. $\times 124$.

the early sternomastoid tumor is an actively proliferating replacement fibrosis of striate muscle without evidence of inflammatory leucocytic infiltration or deposition of hematogenous pigment. The process is sharply delimited by the muscular sheath. An identical lesion has been produced in dogs by Middleton by applying separate ligatures to the venous return from the sartorius. These lesions produced experimentally have, as shown by his description and photomicrographs, no essential differential characters from the changes seen in sternomastoid tumors in human beings. He, therefore, advances the

hypothesis that the etiological factor in the production of sternomastoid tumor is temporary venous obstruction, perhaps followed by thrombosis, resulting from venous compression when the muscle is placed under unusual tension by prolonged torsion of the neck.

The patient upon whom this study is based was operated upon at the Lakeside Hospital by Dr. Elliott C. Cutler. The case is unusual in that it is one of the youngest ever reported, and because of the fact that in the microscopic section blood vessels are seen in which fibrosis and organization have not so far advanced toward cicatrization as to destroy the identity of the vessels. Numerous venous radicles contain organized thrombi, lesions which Middleton states have never been definitely identified in his cases.

CASE SUMMARY

R. F., a white male of six weeks, a first child, was admitted to the Lakeside Hospital on March 12, 1928, with the complaint of a "bony" mass on the right side of the neck, first noticed when the child was one month of age. There was a history of low forceps delivery from a right occipito-anterior position, and the statement was made that the head was traumatized at birth. The history was otherwise unimportant except for the present illness. The mother stated that the child appeared normal at the time of birth. When the infant was one month old, the mother noticed a "bony" mass on the right side of his neck which was not painful on pressure. At the same time she noticed that the child held the head constantly to the left.

The physical examination revealed a well developed, well nourished male infant six weeks of age who held his head constantly rotated to the left and inclined toward the right shoulder. It was impossible even with gentle pressure to rotate the head to the right. The head was slightly flattened over the right parietal region, but showed no other abnormalities. The right sternocleidomastoid was resistant to stretching. A mass of cartilaginous consistency extended throughout its entirety and included both sternal and clavicular heads and stood out on the neck as a tumor mass

$4 \times 1 \times 1$ cm. The eyes, ears, nose, and throat were negative. The thorax, heart, and lungs were normal. The abdomen showed a small umbilical hernia. The genitalia, extremities, and reflexes were normal. Laboratory findings: urine, negative; hemoglobin, 90 per cent; white blood corpuscles, 9200. Roentgenograms of the skull and cervical spine showed no definite evidence of pathological change.

On the second hospital day the right sternocleidomastoid was excised. The entire sternocleidomastoid appeared as a dense white fibrous structure. Upon separating the sternal and clavicular insertions there was slight bleeding from two points. In the upper portion of the muscle more patent blood vessels were encountered. The muscle was resected 1 cm. below the mastoid in an attempt to leave the trapezial portion of the eleventh nerve intact. On the second postoperative day the sutures were removed. The wound healed per primam, and at the time of discharge on the eleventh postoperative day the child moved his head from side to side with ease.

The child was seen in May, 1928, May, 1929, and February, 1931, in the Follow-up Clinic, and on these occasions the late results of operative treatment were reported to be excellent.

Pathological Studies. Culture: A portion of the muscle was placed on dextrose broth and ascitic agar, but no growth was obtained in forty-eight hours.

Gross description of sternomastoid tissue: The specimen consisted of an elongated piece of tissue, measuring $4 \times 1.5 \times 1$ cm. It was rather irregular in outline and of rubbery consistency. On section it was pearly white in color and homogeneous.

Histological Report: The specimen consisted of an irregular mass of fibromuscular tissue which was covered on two adjoining sides by a fibrous sheath suggesting a fascia layer or a capsule. Outside this sheath were several bundles of normal-appearing voluntary muscle as well as several small groups of striate muscle fibers which were the seat of interstitial fibrosis. Within the sheath the character of the tissue varied as the center of the specimen was approached. Immediately beneath the sheath the muscular elements predominated. The muscle bundles were cut in cross and longitudinal sections and were seen to be separated from one another by adult fibrous

connective tissue. Moving inward from the sheath the muscular elements became less prominent and toward the center the tissue consisted of very dense fibrous connective tissue which was especially rich in collagen fibrils. Even here, however, occasional isolated muscle cells were seen, and there was slight increase in number of muscle nuclei. Small groups of lymphocytes were encountered, but there was no diffuse infiltration. The tissue was treated with potassium ferrocyanide and hydrochloric acid and there was no evidence of hemosiderin. Several small blood vessels and nerves were incorporated in the fibrous connective tissue. The small arteries showed in many instances a marked intimal or medial proliferation with definite narrowing of the lumen. To a slight extent around the arteries, but more extensive around the veins, was a definite perivascular infiltration of lymphoid cells. The small veins showed slight thickening of their walls. Several showed in the lumina small dense acidophilic masses of fibrin intermingled with variable numbers of fibroblasts. By means of elastica stains it was found that these organizing thrombi were confined to veins and were not to be observed in arteries.

The histological findings would indicate the process to be in the nature of a fibrous connective tissue replacement of muscle following a degenerative change which was more marked in the center than at the edge. There was no evidence of active inflammation and yet the fibrosis was

progressive. These changes as observed in a sternomastoid tumor removed from an infant of six weeks were consistent with Middleton's hypothesis that venous stagnation and thrombosis are the etiological factors in the formation of a sternomastoid tumor (Fig. 1).

CONCLUSIONS

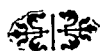
1. Anatomical peculiarities in the circulation of the sternocleidomastoid render it particularly liable to interference from strain upon the muscle when the neck is subjected to extreme torsion, as during parturition.

2. A preponderance of right-sided congenital torticollis is roughly correlated with the preponderance of left vertex positions. It is noteworthy that the normal mechanism of delivery in left vertex positions throws increased strain on the right sternomastoid muscle.

3. The presence of definite venous thrombi in the case reported here (findings not reported in any of Middleton's cases) lends support to Middleton's conclusion that the essential factor in the production of sternomastoid tumor of congenital torticollis is temporary venous occlusion at the time of parturition followed in at least certain cases by venous thrombosis.

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COMPLETE LOSS OF FEMALE URETHRA & BLADDER FLOOR*

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COMPLETE loss of the urethra is of comparatively rare occurrence and there are not many cases in the literature.

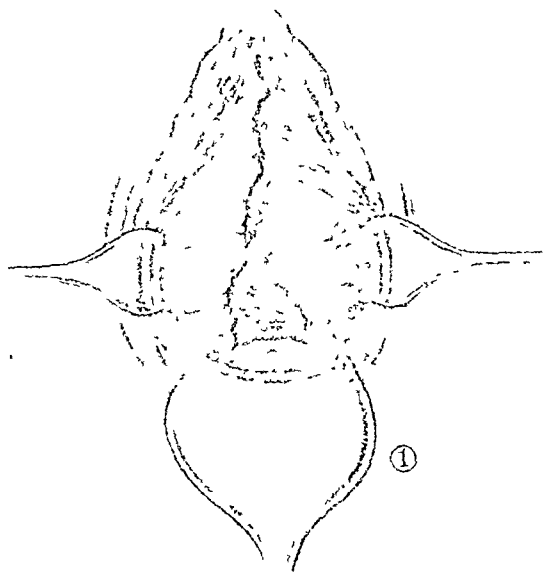


FIG. 1. Complete rupture of female urethra with loss of bladder floor. Note narrow rim of tissue in front of cervix and scalloped edges of opening.

Noble states that he has heard Emmett say that in his large experience, although he had succeeded in six or seven cases in restoring the urethra, all of them were unsatisfactory and he would abandon further attempts. In both Noble's and Kelly's cases, pressure with a tampon or special pessary was necessary to insure control. Baker Brown seems to have had unusual success in three cases he has reported.

With these words George Gray Ward sums up his article in Lewis's "Surgery" on the subject of destruction of the female urethra. He reports 1 case of his own in which the defect consisted of a destruction of the under side of the urethra, including the neck of the bladder, where there was

an opening into the bladder the size of a twenty-five cent piece. By turning a long flap upward from the base of the bladder and slipping it under a tunnel in the vestibule, he succeeded in constructing a serviceable urethra. His work was based upon the technique devised by Kelly, who reports 2 cases and quotes Noble as having operated upon another. In none of these 3 cases was urinary control established, and the patients had to wear pessaries to press the urethra together and prevent leakage. The method followed by Noble was to dissect up the labium minus on one side and slide it over the urethral trough, fastening it in place and allowing healing to occur. These 4 cases, with 3 others reported by Brown of London, comprise all that I can find in the literature.

In none of these cases where the details are given was there more than a destruction of the urethra with a small defect of the bladder. It is my privilege in this paper to report an eighth case successfully repaired, in which the injury was not only a destruction of the urethra but of virtually the entire base of the bladder as well.

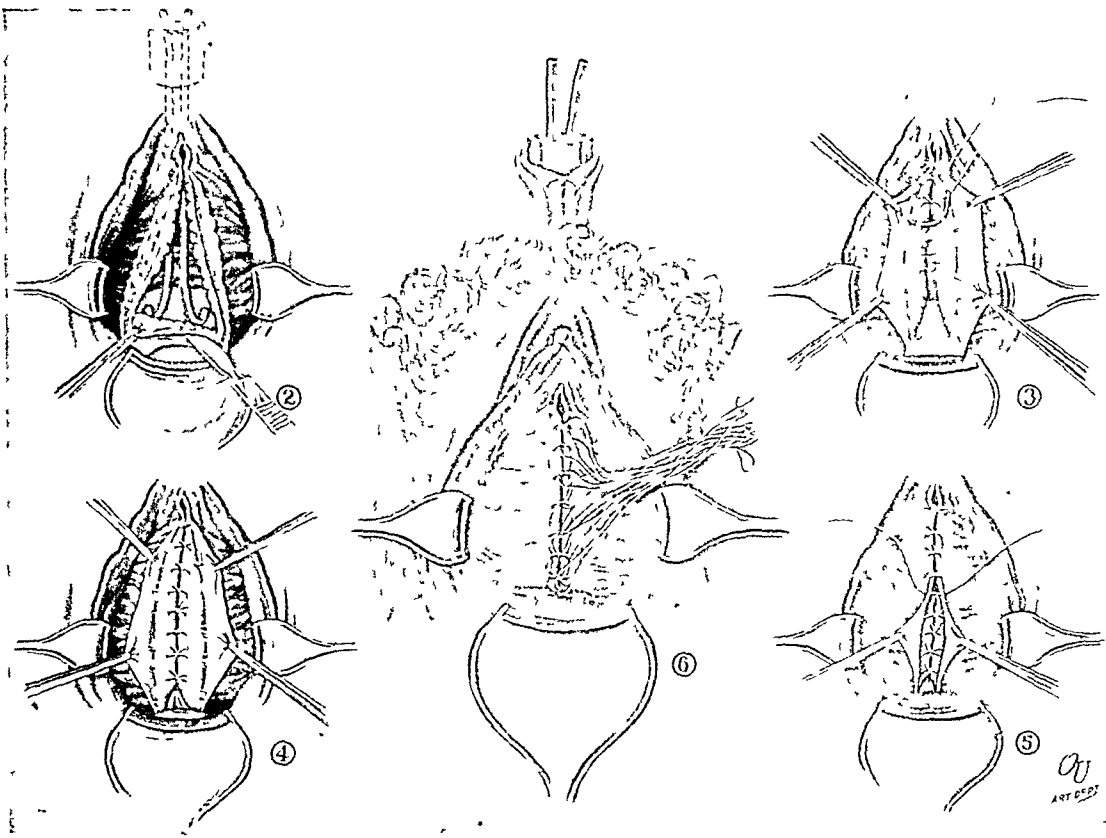
CASE REPORT

Mrs. P. M., aged twenty-four, University Hospital No. 53080, was operated upon in December 1928 in another state for "falling of the womb." After eighteen days in the hospital she went home. Two months later she had difficulty on urination and finally could not void for twenty-four hours. She was catheterized by her family physician, who told her that she was hysterical and would get better. She did not, however, and he taught her to catheterize herself. A few days afterward she returned to the hospital where she was told that she had inflammation of the bladder. After two weeks she was cystoscoped, and the

* Submitted for publication September 22, 1931.

cystoscopist said that he saw a number of stones in the bladder; that these stones had eroded away the floor of the bladder until

of months she came to Oklahoma City, where she tried to get help but failed. Finally she grew despondent and attempted suicide by



FIGS. 2-6.

FIG. 2. Catheters have been passed to each kidney and their ends brought out through suprapubic wound. This wound is held widely open by large rubber tube drain. Lower dissection shows line of cleavage between bladder and vaginal wall.

FIG. 3. Dissection completed. Suturing begun with No. 1 chromic catgut, turning edges of bladder and urethra inward without tension.

FIG. 4. Second row of chromic sutures placed outside first row, rolling edges further in. A third row was placed in like manner, with slight tension.

FIG. 5. Placing first row of silkworm gut sutures through deep portion of vaginal flaps.

FIG. 6. Completed operation. Sutures left long for convenience in removing.

they were almost in the vagina; and that the manipulation of the instrument broke the thin wall through, causing a vesicovaginal fistula. After this accident the tissues about the vagina swelled enormously so that a tube had to be inserted into the vagina to allow the urine to escape. At this time also a suprapubic opening was made, through which eight stones were removed. Some weeks later, after she had regained her strength and courage, she was again operated upon for the purpose of repairing the vesicovaginal fistula. This was unsuccessful, and left a larger opening than before. Another attempt ended likewise, and she was dismissed as hopeless. After a number

taking lysol. She was rushed to the hospital, where proper treatment saved her life.

At this point I examined her and found that the entire urethra and floor of the bladder had sloughed out, leaving only a narrow rim of tissue about $\frac{1}{2}$ in. wide just anterior to the cervix. On pressing the posterior vaginal wall backward and separating the labia one could look directly into the bladder cavity. Each ureteral orifice could be seen about $\frac{1}{2}$ in. lateral and superior to the edge of the bladder opening. Urine trickled from the vagina continually, and in spite of pads, perfumes, etc., there was an odor of urine constantly about her.

At first thought it appeared that the proper thing to do was to transplant the ureters into the bowel, as had been suggested by her

orifice to the opening in the bladder, skirting around this on each side and ending at the cervix, where a transverse incision joined the

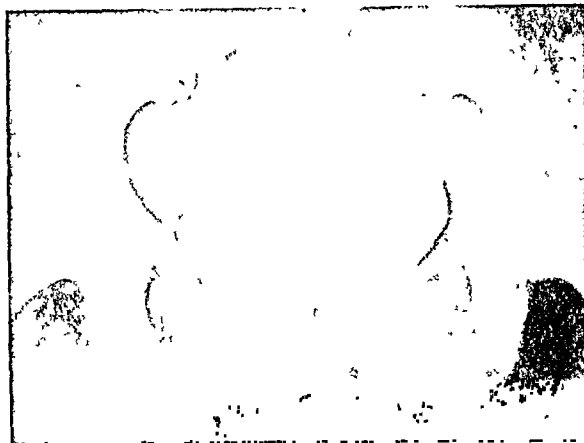


FIG. 7. Cystogram and urethrogram (antero-posterior view) two and one-half months after operation. Showing normal bladder outline and good urethral sphincter. Bladder was filled with 10 oz. of 8 per cent sodium iodide solution and urethra was injected with bismuth paste.



FIG. 8. Same as Fig. 7, except taken in Sims' position to show lateral view of reconstructed urethra.

previous doctors. This idea was concurred in by several consultants, who felt that no other plan would be feasible. After considering it for several days, however, I decided to make one more attempt at repair before resorting to such a drastic step as transplanting ureters. The patient was willing for anything, since she had fully decided to end her life unless I succeeded in repairing the defect.

Operation: On December 3, 1930, she was placed in a lithotomy position and the vagina prepared by scrubbing with alcohol. A weighted speculum was then inserted and the cervix uteri grasped with forceps and pulled outward. The edges of the bladder opening were retracted and the ureteral orifices showed up plainly. A No. 6 x-ray catheter was inserted in each and pushed upward until it reached the kidney. A suprapubic opening was then made in the bladder large enough to receive a rubber tube 1 in. in diameter. This was sewed in place and the wound closed in the usual way. The lower end of each ureteral catheter was turned upward and brought out through this rubber tube which was cut off $\frac{3}{4}$ in. above the skin, leaving only a stiff rubber ring holding the suprapubic opening well apart.

Two long incisions were then made parallel to each other and $\frac{1}{4}$ in. lateral to the remains of the urethra, extending from the external

posterior ends. These incisions went through the vaginal mucosa and were outside the area of scar tissue. The bladder wall was then dissected loose from the vaginal mucosa for $\frac{1}{2}$ in. or more on each side. This mobilization of tissue was continued along the side of the urethra until the medial edges of the para-urethral incisions could be turned inward and overlap each other slightly. The tissue in front of the cervix was thoroughly loosened, the line of cleavage between bladder and vaginal wall was found and the two were separated as far upward as appeared safe. By then turning the vaginal surface upward toward the bladder about one third of the bladder defect was filled.

The next step consisted of one row of chromic No. 1 catgut sutures, placed as close to the turned in edge of bladder and urethra as possible. The sutures were interrupted and were placed in the urethra first, continuing downward on the bladder as far as possible without producing tension on the tissues from side to side. It was found that this row could be carried to about $\frac{3}{4}$ in. of the cervix. At this point the turned up flap of vaginal wall was sewed into the opening, thus closing the entire bladder without tension. A second row of sutures was then placed exactly like the first, except that they were outside the first and turned the flaps inward a little farther. Still a third row was placed likewise, resulting in a perfectly water-proof closure of the

bladder and urethra, and bringing nearer together the dissected flaps of vaginal mucosa. Silkworm gut sutures were then placed through the bases of these flaps, drawing them together with slight tension (which naturally lessened any tension there might have been on the bladder wall inside). Since these flaps projected about $\frac{1}{3}$ in. outside the sutures, there was ample surface for union which was not under tension. The silkworm sutures were left long and tied together in one bundle for convenience in removing. A gauze pad covered with vaseline was placed behind the cervix, lifting it and the suture line forward. Another gauze sponge was wrapped around the bundle of silkworm sutures to prevent irritation of the vestibule, and the patient was returned to bed.

Postoperative Course: The foot of the bed was elevated 6 in. and each ureteral catheter was placed in a bottle. A strip of adhesive held them in place on the patient as they came through the dressings. Fluids were restricted to 500 c.c. daily and food to 500 calories daily, for the purpose of lessening the amount of urinary secretion. After six hours the dressings were turned back and a rubber catheter gently lowered into the bladder and 100 c.c. of urine aspirated out, which had leaked down along side the ureteral catheters. This was repeated every two hours day and night, for the first week. It was soon found that the ureteral catheters were handling very little of the urine, hence on the third day they were removed. At no time did more than one third of the urine come through them. After the third day the bladder was gently flushed out with boric acid solution each time it was aspirated. Beyond an occasional temperamental outburst, which had to be handled tactfully by nurses, internes and surgeons, her progress was perfectly smooth. The gauze was changed in the vagina every three days, and a few sutures were removed on the tenth day. A few more were removed every two days until all were out by the sixteenth day. The wound healed by first intention except for a pinpoint opening next to the cervix, which yielded to one slight injection of silver nitrate. The suprapubic tube was left in until the eighteenth day, then was removed. The opening left by this was closed entirely on the thirty-fifth day. Prior to this I had slipped a small uterine probe through the newly made urethra and found it patent.

On the thirty-first day she developed a pain in the region of the right kidney and a fever of 100 to 103°F. Considering this to be a pyelitis, I persuaded her to allow me to cystoscope her, using a size twenty Brown-Buerger instrument. The interior of the bladder was still considerably inflamed and the infolded edges were raw and rough. I lost my courage and did not catheterize the ureters for fear of injuring the newly united tissues. She voided through the urethra on the thirty-fifth day and had perfect control. She told me at this time that her sensations of urination were perfectly normal, and as if she had never been incontinent. Her pyelitis slowly improved under fluids and alkalies and the bladder irritation improved until she could sleep all night without getting up. I cystoscoped her again on the fifty-seventh day, and found that the bladder had cleared up beautifully, the interior being perfectly smooth except for a small rough place about 1 cm. in diameter at the posterior end of the scar. She left the hospital two days afterward, completely healed, comfortable and perfectly continent. Two weeks later she came to my office, and I injected 6 oz. of 8 per cent sodium iodide solution in the bladder, then injected warm bismuth paste in the urethra for x-ray pictures. The bladder held these substances without the slightest distress or leakage. She is now working as a housemaid.

The problems presented by this case were twofold:

1. To repair the opening in the bladder and create a new urethra.

2. To establish a functioning sphincter.

The first of these was the more difficult because of ever-present urinary irritation and the large amount of scar tissue from previous operations. The urinary irritation was overcome by ureteral catheters, by raising the foot of the bed very high, thus causing such urine as did accumulate to roll backward into the fundus of the bladder, and by constant, persistent drainage every two hours day and night. To this was added the extra precaution of restricting both fluids and food so that there would be very little urine excreted. These postoperative measures undoubtedly contributed a great deal to the success of the undertaking.

The question of scar tissue was very difficult, but by going entirely outside of it and turning in flaps of healthy vaginal wall it was much easier to sew several rows of sutures without tension than it would have been otherwise. Perfectly free mobilization of the bladder wall was aimed at, regardless of how small the completed organ might be, hence wide dissection to each side was made. The urethra was handled in the same manner, turning in ample flaps and placing sutures Lambert-wise through only the outer surface so as to avoid injury to circulation. No tube of any kind was left in the urethra, as a stricture would have been preferable to a breaking down of the sutures. The flaps were rolled in by three rows of sutures, thus closing the lumen snugly and under very slight tension, which was later reinforced by pressure from the vaginal wall flaps.

The perfect sphincteric action can be attributed to the fact that the third row of sutures at the bladder neck was definitely placed in the bladder wall, thus bringing a

ring of detrusor all around the opening. Since this muscle is normally under tonic contraction it acts like a rubber band around the urethra and keeps it closed until such time as increased hydraulic pressure inside the bladder forces it open.

SUMMARY

A search of available literature shows but 7 reported cases of complete destruction of urethra. None of these was accompanied by complete rupture of bladder floor. In only 4 are details available and the results obtained were completely satisfactory in only 1 of these. In this one the bladder floor was present and could be used for turning a flap forward in the building of a new urethra.

To this list is added an eighth case in which the entire urethra and bladder floor have sloughed out. The repair was accomplished by free mobilization of the side walls and careful postoperative management. The result was perfect, both anatomically and functionally.



DIVERTICULUM OF THE JEJUNUM*

WITH CASE REPORT

SYDNEY K. BEIGLER, M.D., ARTHUR R. BLOOM, M.D., AND JOSEPH WRUBLE, M.D.

DETROIT, MICH.

JEJUNAL diverticula are sufficiently infrequent to warrant the report of this case in which the diagnosis was made by the roentgenologist (Dr. Bloom) and confirmed by operation.

CASE REPORT

A male, twenty-nine years of age, was admitted to the hospital on March 9, 1931 complaining of epigastric pain. His past and family history was essentially unimportant. His present illness dates back to about one and one-half years ago at which time he began to have epigastric pain usually localized to the left of the midline. The pain, at times, was quite severe and would come on about one to two hours after meals. Accompanying the pain there was always nausea and eructation of gas. Soda would give him relief but only temporarily. The attacks became frequent and after consulting several physicians he was placed on an ulcer diet which modified his symptoms to some extent for short periods but they always recurred. Gastrointestinal x-ray studies failed to reveal any organic lesion and the patient was again placed on an ulcer diet, without any apparent improvement. At this time a more careful and thorough x-ray investigation of the gastrointestinal tract (by Dr. Bloom) revealed a diverticulum of the jejunum.

The laboratory examination showed a normal blood and urine and his Wassermann reaction was negative.

After several days of hospital observation, the patient was operated upon. Through a right rectus incision the abdominal viscera were explored and found to be negative except for a diverticulum of the jejunum situated about 40 cm. from the duodeno-jejunal junction. It was located on the mesenteric border surrounded by many firm adhesions which bound the diverticulum down to the mesentery. The outer wall was slightly inflamed and in conjunction with the presence of the adhesions

indicated an inflammatory process in the sac. The adhesions were severed and the diverticulum isolated throughout and was found to be about 3 cm. long and 2.5 cm. wide. This diverticulum was resected through a longitudinal elliptical incision and sutured transversely. The appendix was removed secondarily.

PATHOLOGICAL REPORT: "The diverticulum is lined with intestinal mucosa with high villi and small glands. It is congested, infiltrated with numerous lymphocytes, a few eosinophiles and numerous small hemorrhages. The muscle coats are extremely thin and the vessels of the peritoneal layer are markedly distended. *Diagnosis:* Early acute diverticulitis."

The patient made an uneventful postoperative recovery and was discharged in excellent condition. Six months after the operation we find the patient in good health, entirely free from all of the symptoms which he had previous to the operation. At present he has had no food discrepancy whatsoever.

DISCUSSION

Diverticulum of the gastrointestinal tract is not an infrequent finding. Meckel's diverticulum is a well-known operative finding. Next in frequency they are to be found in the duodenum and large intestine, particularly the sigmoid. Diverticulum of the jejunum, however, is a very infrequent finding. A thorough investigation of the literature reveals only 38 cases, most of which were found at necropsy. Out of this number only 9 were diagnosed preoperatively and confirmed by operation. Our own case increases the number to 10. Several cases are on record where a diagnosis of diverticulum of the jejunum was made by x-rays findings but the diagnosis was not confirmed either by operation or necropsy. Case in 1920 reported 5 cases where a

* Submitted for publication September 8, 1931.

diagnosis of jejunal diverticulum was established roentgenologically but only 2 of which came to operation and the diagnosis confirmed. The non-operative patients, however, presented the typical symptoms and the x-ray findings were so characteristic that there was no doubt in his mind as to the correctness of his diagnosis.

Diverticula of the jejunum may be single or multiple but more frequently they are single. They may occur at any age although Rothschild claims that they are more likely to be found in individuals past fifty. There seems to be considerable discussion and discrepancy as to whether they are acquired or congenital. Those who contend that they are congenital point out the fact that other anomalies of the intestinal tract are found to coexist, but in most cases we feel that they are acquired and that they are due either to a natural weakness of the bowel wall or that the weakness is artificially created by inflammation, ulceration, increased intestinal pressure or other pathological processes.

The symptoms presented vary a great deal. They may be absent entirely as evidenced by the fact that most of the jejunal diverticula are found accidentally. If symptoms are present they are essentially the same as those of a duodenal ulcer. In fact all of the cases reported have been treated for duodenal ulcer before discovery was made that a diverticulum existed. The symptoms consist largely of gastric distress one to two hours after meals. There is considerable nausea and occasionally vomiting. The pain is marked at times and located to the left of the midline in the epigastric region. Palpation of this area will reveal a tender spot and that is usually the

location of the diverticulum. If the diverticulum has an inflammatory process the tenderness will be more severe and permanent. The symptoms produced depend a great deal upon the size of the orifice of the diverticulum. If the orifice is large, the diverticulum will be able to empty itself of all the food particles which enter. If it is small, the food material will remain within the diverticulum and undergo decomposition, resulting in inflammation and antiperistalsis, the caustive agents in producing the symptoms. The course of the jejunal diverticula also resembles very much that of duodenal ulcer in that they respond very favorably to a medical treatment for a period of one to three years but after that time the symptoms become more pronounced and one is forced to resort to surgical interference.

The diagnosis is never established clinically, but roentgenologically. The roentgenologist must be very observant and if he sees a suggestive lesion must be willing to repeat the examination several times before he discharges the patient. Fortunately in the past ten years with the marked improvement of the x-ray technique and diagnosis, a number of cases have been diagnosed by the radiologist which formerly would have been missed.

The treatment should be surgical as soon as the diagnosis is established. If the diverticulosis is multiple it may be necessary to resect part of the jejunum or to perform a low gastroenterostomy. If single, resection of the diverticulum offers the best results. In the reported case where the diverticulum was resected, we find the patient six months after the operation to be free of any symptoms.

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MIGRATORY COLON

CASE REPORT*

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WHILE anomalies of the colon have been so frequently observed and reported as to make them common-

She tires easily on exertion. There was no history of abdominal colics of any kind.

Physical examination showed a slightly

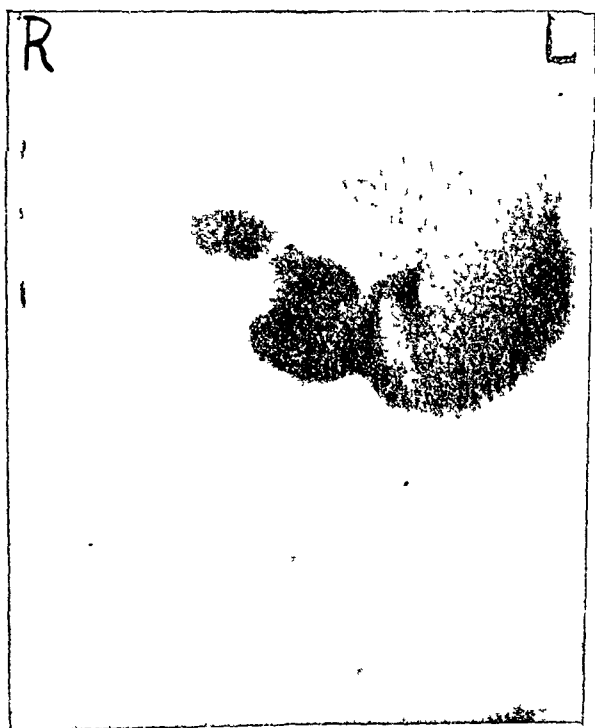


FIG. 1. Dilated duodenal bulb and almost vertical duodenal loop.

place, the following case report is offered because it demonstrates an unusual mobility of the colon and the value of prolonging colonic studies through the forty-eight hour and enema observations.

CASE No. 18213. White female, aged sixty-two. Referred by Dr. E. B. Anderson.

Chief Complaint: Shortness of breath, spitting of blood, and nausea.

History: For several months she has had occasional attacks of nausea and gas formation. One month ago, she became nauseated and vomited a small amount of blood. This has continued at intervals for the past two weeks.



FIG. 2. Twenty-four hour film, showing cecum and ascending colon on left.

dyspneic, elderly female, with a small epithelioma on the left lower lip, cardiac hypertrophy and arrhythmia, gaseous distention of the abdomen, and generalized tenderness, with a suggestion of a movable mass in the left lower quadrant, which appeared to be connected with the bowel. Blood pressure 170/120.

While the physical and clinical findings pointed to cardiac pathology with abdominal manifestations, she was referred for roentgen examination of the gastrointestinal tract in order to rule out a neoplasm and identify the mass in the left lower abdomen.

The esophagus and stomach showed no lesions, but the duodenal bulb was moderately dilated and the usual c-shape of the duodenal loop was replaced by an almost vertical position of the second and third portions. At the six and twenty-four hour observations the cecum and proximal colon were found in the left lower abdomen, but at forty-eight hours had resumed their normal position on the right. There was

* Submitted for publication September 24, 1931.

redundancy of the transverse colon. A barium enema demonstrated the right colon in normal position, with redundant coils of the trans-

versary migration of the right colon into the left abdomen, presumptive evidence of an unusually long colonic mesentery. In the event

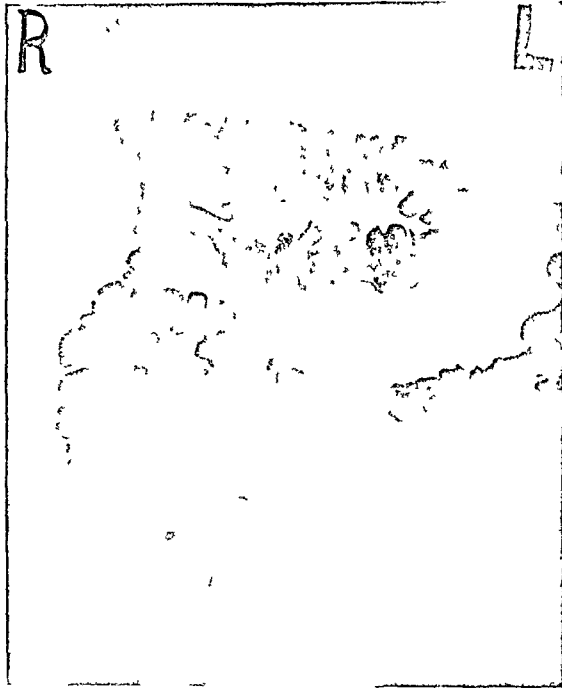


FIG. 3. Forty-eight hour film, showing normal position of cecum.

FIG. 3. Forty-eight hour film, showing normal position

verse colon and sigmoid. The usual sharp angle of the hepatic flexure was absent.

Had the roentgen observations ended at twenty-four hours a diagnosis of fixed non-rotation of the right colon would have been returned. Instead, the later observation demonstrated an unusual colonic mobility, with

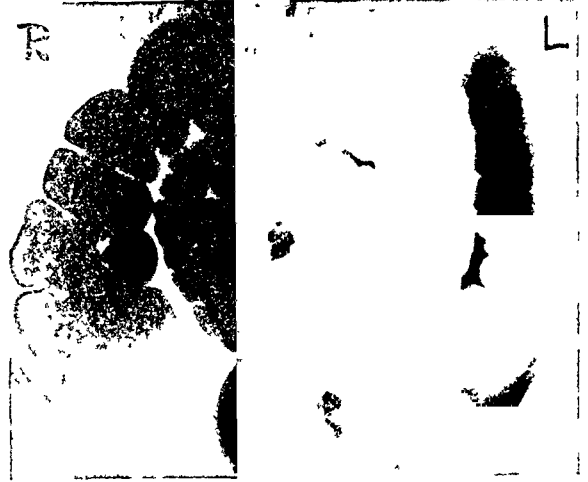


FIG. 4. Barium enema. Film showing normal position, with large sigmoid coils.

of an attack of appendicitis, localization of pain might occur almost anywhere in the abdomen. Fluoroscopic observation showed the suspected mass in the left lower abdomen to be caused by the distended cecum during its transitory migration of the right colon into the left abdomen, presumptive evidence of an unusually long colonic mesentery. In the event the anomalous position of the duodenum illustrates a partial non-rotation, and it is likely that there is also a long duodenal mesentery.

It is interesting to note that these intestinal anomalies had existed for sixty-two years without producing any noticeable symptoms until cardiac disease supervened.



EFFECT ON THE KNEE OF A SHORTENED GASTROCNEMIUS MUSCLE*

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THE number of cases in which I am consulted where a diagnosis has been made of chronic synovitis, arthritis or internal derangement and where the primary etiological factor has been interference with the normal mechanism of the knee, due to a shortened gastrocnemius muscle, is steadily increasing.

The greatest difficulty arises in differentiating between limited motion as an etiological factor and as a result of or concomitant with disease or injury. The gastrocnemius muscle when of normal length, with the knee in extension, permits of dorsal flexion at the ankle to 85 degrees or less. If the muscle is shorter than normal and the knee is straight, dorsal flexion can be obtained to only 90 or 100 degrees; or dorsal flexion to its normal extent may be obtained by flexing the knee, thus bringing the heads of the muscle above the femoral condyles closer to the insertion of the tendon into the os calcis. So, if the muscle is short and the foot is used normally in walking, the knee is not fully extended. The knee is in its strongest position when fully extended. When slightly flexed, the internal lateral ligament is relaxed, permitting abduction and then a ligamentous strain, the antero-posterior plane containing the center of gravity is slightly mesial to the midline of the astragalus and the transverse plane containing the center of gravity is slightly anterior to the normal weight-bearing line of the tibia, so that excessive muscular effort is necessary to support the body at the knee and there is a tendency to strain of the internal lateral ligament, to displacement of the semilunar cartilage and to a general strain of all the structures about the knee. The vulnerability of the joint lessens its resistance to all forms of trauma, minute

as well as gross, and to other arthritic conditions, rheumatic and infectious.

It is very often difficult to evaluate the presence of the shortened gastrocnemius in connection with other etiological factors; but if Nature limits extension it is well to follow her directions and put it outside the power of the patient to voluntarily or involuntarily move the knee through a greater arc than comfort allows. Whether the case is one of internal derangement, chronic synovitis or arthritis from any origin, this rule should usually be followed. It is a much better one than that of absolute immobilization, if Nature makes no protest to a limited movement.

This can be accomplished by the use of a peg-stop brace. A long outside bar extends from the foot plate to the great trochanter, with joints at the ankle and knee, and an inner bar extends from mid-calf to the groin, with a joint at the knee. These two bars are united by posterior bands at calf and thigh and straps over the leg and thigh. The inner joint at the knee is free. The outer one is so made that a screw-peg prevents full extension. This peg can be screwed up or down to regulate the range of movement. It should limit extension shortly before movement at the knee is limited by spasm or causes pain. This limitation of extension also prevents the rotation which takes place at the end of extension. With such a brace the patient can safely do anything which the brace permits. If it is properly fitted he will be able to kick out freely, the peg stopping movement before apprehension is felt.

After the knee symptoms have disappeared, if the gastrocnemius is still shortened, the traction shoe will correct the condition if dorsal flexion to 95 degrees is possible. Otherwise a lengthening of the tendo Achillis is necessary.

* Submitted for publication August 17, 1931.

NEW INSTRUMENTS

A WALKING CAST

FOR AFFECTIONS OF THE LOWER LEG*

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MERIDIAN, MISS.

THE peg leg cast of Dr. L. Roeren of Suchteln, Germany, described by Dr. W. P. Blount of Milwaukee¹ for use

of the lower leg. This cast, however, is not used by us in fractures of the upper third of the tibia.



FIG. 1. Walking cast completed.

in the treatment of coxa plana has suggested to us a cast on the same principle which is most useful for the ambulatory treatment of fractures and other affections

In fractures of the tibia and fibula reduction is accomplished and maintained on the fracture table with the knee flexed to a 90 degree angle. The upper third of the thigh and the distal third of the foot are encircled with stockinette. A thin layer of sheet wadding is applied to the foot, leg and thigh. A thin layer of felt is placed over the entire anterior surface of the tibia and a thick felt pad is placed over the anterior surface of the knee, extending well down below the tubercle of the tibia. A plaster cast is applied from the upper third of the thigh to the toes. The stockinette is turned back over each extremity of the cast and fixed with two or three turns of plaster bandage.

After the plaster has set the upper fourth or third of a crutch is sawed off, the two upright pieces are sprung over the medial and lateral aspects, respectively, of the cast and incorporated with several more turns of plaster (Fig. 1). It is usually necessary to move the cross bar of the crutch downward a few inches so that the peg leg will be the same length as that of the sound leg. The cast is most comfortable.

¹ *J. Bone & Joint Surg.*, Jan. 1931.

* Submitted for publication August 10, 1931.



URETHRAL AND VESICAL ASPIRATOR*

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NEW YORK

THIS aspirator is made of tubing, the outside diameter of which is 2.5 mm. It measures 18 cm. from the tip to the or by placing the tubing or bulb over the flared portion. The shell may be removed for cleansing.

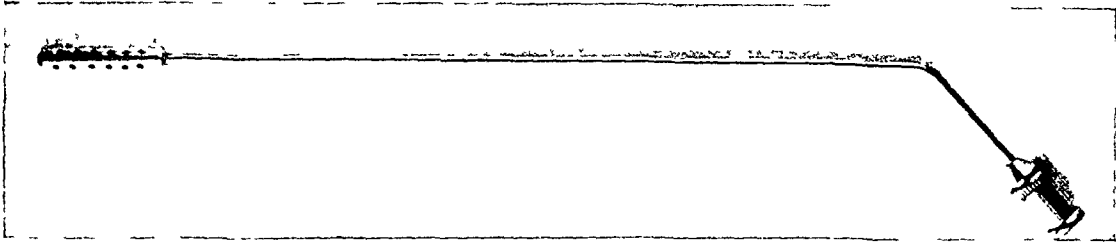


FIG. 1.

bend. The shell at the distal tip is 4.7 mm. in diameter, and 2.5 cm. long. It is built on the principle of the Poole aspirator.

The small tube extends almost the length of the shell, which has many perforations; these prevent damage to the bladder and urethral mucosa, for it cannot be sucked into any of the holes as long as one or more holes remain uncovered. The distal end is fashioned so that it may be connected to a bulb, or to a suction apparatus, either by a slip joint connection

I have found its greatest value in the treatment of urethritis in the female; before its adoption it was necessary to have the patient in the knee-chest posture in order to get a well dried urethra to which to make topical applications.

In use I have allowed the tip to be in the bladder, as I withdrew the endoscope into and past the sphincter, without any fear that mucosal damage would result from suction.

* Submitted for publication April 16, 1931.



INSTRUMENT FOR ELEVATING OF THE NEWBORN CRANIAL DEPRESSIONS*

JEFFERSON BROWDER, M.D.

BROOKLYN, N. Y.

THE ease with which the newborn head moulds during birth precludes frequent depressions of the flat skull

pelvis, an unusually large promontory of the sacrum, or the obstetrician's forceps. There are two common types of depres-

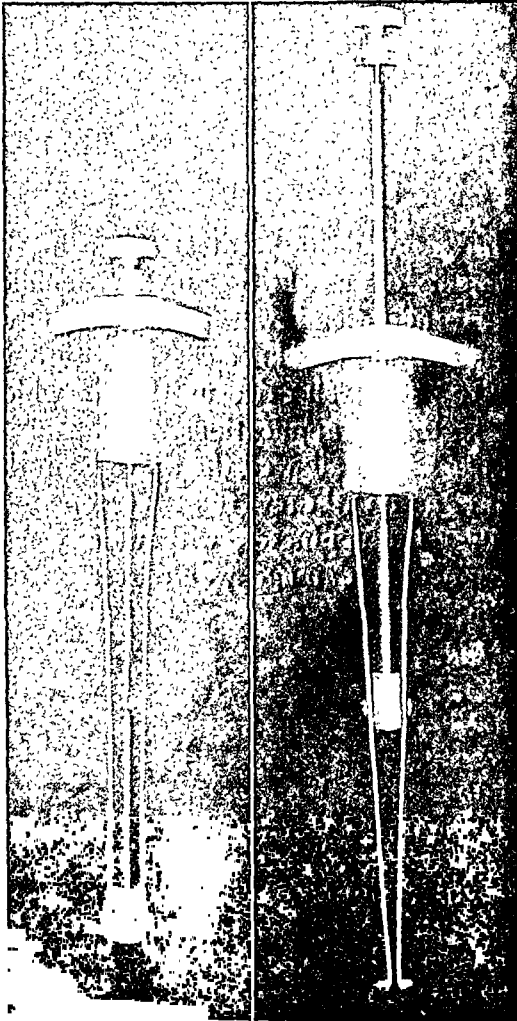


FIG. 1. Photograph of instrument.

bones. In some instances undue force is brought to bear on a local area with a resultant impression which may or may not be associated with fissure fracture. Such type of injury may be due to a deformed



FIG. 2. Example of type of lesion which may require open operative elevation.

sions, cup-shaped and groove. The former occurs more often in the frontal bones whereas the latter is seen in the parietal areas.

In instances where the depression is an indentation of a portion of one of the flexible cranial bones and unassociated with a fissure fracture, one may by properly applied pressure convert the concave area into a normal convex surface. When such manipulation fails to restore the normal contour of the skull the condition can be successfully treated only by open operation.

Several types of instruments have been devised for this procedure, each aiming at

* Submitted for publication November 4, 1931.

simplifying the operation, but many are unsafe owing to the danger of injury to a cortical vessel. Because of the inadequacy of these instruments the author has devised a simple type of elevator which is both safe and satisfactory.

A brief description of the operative steps are as follows:

1. Under local anesthesia make a 3 cm. incision directly over the area of maximum depression.

2. Insert mechanical retractors which will also control bleeding.

3. Make a u-shaped incision in the periosteum, reflecting the free portion.

4. Burr opening in the skull just large enough to admit elevator tips.

5. Free dura about bony opening.

6. Insert elevator and push the spreading plunger downward.

7. Slowly apply traction until depressed bone is elevated.

8. Cover the bony opening with the reflected portion of periosteum and close the wound.

The advantages of this method are that the procedure can be performed in about ten minutes; every step is under visual control; the bone edges are not split as often occurs in using a hook, and the dura is not opened.

The resultant cranial opening is negligible and at the end of one year one cannot palpate this small defect.



The American Journal of Surgery

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The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the Country, but it is *not* "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

EDITORIALS

OBSTETRIC MORTALITY

FOR many years obstetricians have been concerned with the high mortality rate in obstetrics in the United States. A large literature has accumulated on this subject. Many cure-alls have been suggested.

Probably the greatest stride in the right direction resulted from the White House Conference on Child Health and Protection. For those who did not attend this conference a small book on Obstetric Education,¹ being the reports of the subcommittees on obstetric teaching and education, and that on education of physicians, which includes undergraduate

and graduate education, has been published.

To those interested in this wide subject we heartily recommend this book. It is so full of meaty suggestions, constructive criticism and ways for improvement that the best we can do is to quote some of the more pertinent sentences which left their impression.

There have been and still are too few well organized women's clinics in connection with medical schools to give the necessary training and experience to medical students, to say nothing of the dearth of facilities for developing specialists in this field. . . . There are three major problems in obstetric training and education from the medical standpoint: (1)

¹ Obstetric Education. A publication of the White House Conference. N. Y., Century, 1932.

adequate discipline of the undergraduate student; (2) postgraduate training, and (3) graduate instruction. . . . In so far as obstetrics is concerned, the majority of students at the time of graduation are not qualified to assume responsibilities of caring for maternity cases. . . . We feel that an internship with an adequate maternity service should be required, but whether the state or school should make this training obligatory, may be a debatable question. . . . The best type of physician never completes his education. He is always moving forward. We feel that, if the recommendations of the committees on undergraduate and graduate education of medical students were carried out, that there would be real progress in obstetric practice, with marked lessening of maternal, fetal, neonatal, and infant morbidity and mortality. . . . The bed accommodation in general hospitals is still very inadequate for teaching purposes, and the time devoted to this branch of medicine is too short. As a subject of instruction midwifery should rank equally with medicine and surgery. . . . The Committee can see no justification for the practice of permitting students, unaccompanied by a competent instructor, to deliver women in their homes. . . . In one hospital with 867 deliveries, 644, or 74.3 per cent, had labor terminated by forceps, version or cesarean section. This hospital is on the list of hospitals approved for internships and had six interns. . . . Our maternal mortality rate exceeds that of any and all continental countries: it exceeds that of Canada and some of the republics of South America—in short, it is one of the highest in the civilized world. We could go far in correcting this disgraceful state of affairs if our teaching institutions would provide adequate facilities for clinical instruction in obstetrics. . . . The American

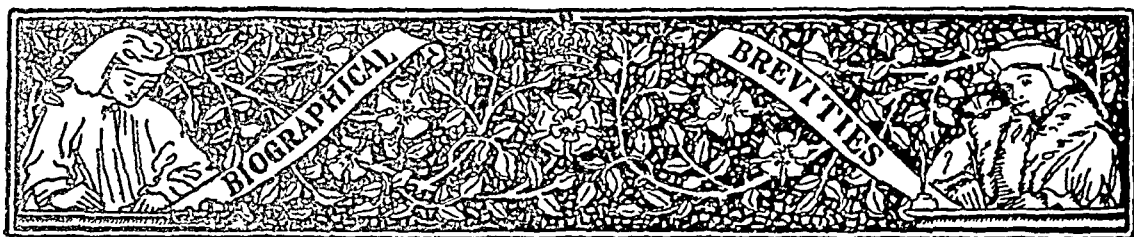
Gynecological Society, the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, the Section on Obstetrics, Gynecology and Abdominal Surgery of the American Medical Association are uniting in making overtures to the Council on Medical Education for a larger recognition of obstetrics in the curricula of our medical schools. *As yet they have not received satisfactory consideration from the council.* [Italics ours. Ed.] The application of the basic sciences to obstetrics can only be satisfactorily taught by a qualified obstetrician. . . . The Committee would emphasize the importance of a resident maternity service for undergraduate and graduates. A well ordered maternity service with sufficient clinical material, is the *sine qua non* of the clinical teaching of obstetrics. There is no adequate substitute. The ideal would be a detached maternity hospital in close proximity to the university hospital and under university control.

The White House Conference is over and the reports of its meetings are being filed away for future study by those who are sufficiently interested in the subject. The cheering is over, as it were. We wonder if those in authority will heed the valuable and practical suggestions offered, and see that they are made effective. We fear that it will result in causing a lot of talk at one time, printed pamphlets on dusty shelves, and that one day, in the distant future, some one will discover the obstetric maternal mortality in the United States is a disgrace to any civilized nation—and start the agitation all over again. We base our pessimism on "water that has gone over the dam."

T. S. W.



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AMERICAN PHYSICIANS

CASPAR WISTAR

CASPAR WISTAR, whose parents were of German extraction, was born in Philadelphia, September 13, 1761. His grandfather founded the first glass works in this country at Salem, N. J. The Wistars were Quakers and Caspar as a boy went to Friends' School, founded by William Penn.

It is said that young Wistar acquired a desire to study medicine during the battle of Germantown on October 4, 1777, at which he helped to care for the wounded. He became a private pupil of John Redman and worked with John Jones. At the same time he attended the lectures of Drs. Morgan, Shippen, Rush and Kuhn at the newly organized Medical School of Philadelphia. He attained the degree of Bachelor of Medicine (1782) and then went to England for a year. From there he went to Edinburgh and in 1786 received his degree of Doctor of Medicine.

He returned to Philadelphia, where Dr. Jones was then the foremost surgeon. He took Wistar under his wing and the latter was appointed physician to the Philadelphia Dispensary, and in 1789 to the professorship of chemistry and physiology in the College of Philadelphia. He was physician to the Pennsylvania Hospital from 1793 to 1810. Also, he became a Fellow of the College of Physicians.

Due greatly to Wistar's efforts the medical school connected with the University of Pennsylvania and the College of Philadelphia were united. After the consolidation he was associated with William Shippen as Adjunct Professor of Anatomy, Midwifery and Surgery in the University of Pennsylvania. Later surgery and midwifery became separate departments. After Shippen's death (1808) Wistar was made Professor of Anatomy. He was a teacher of parts. He published a "System of Anatomy" designed to be a textbook for his classes. It was a good work. He published several memoirs in the *Transactions of the American Philosophical Society*. He made a notable contribution to the anatomy of the ethmoid bone.

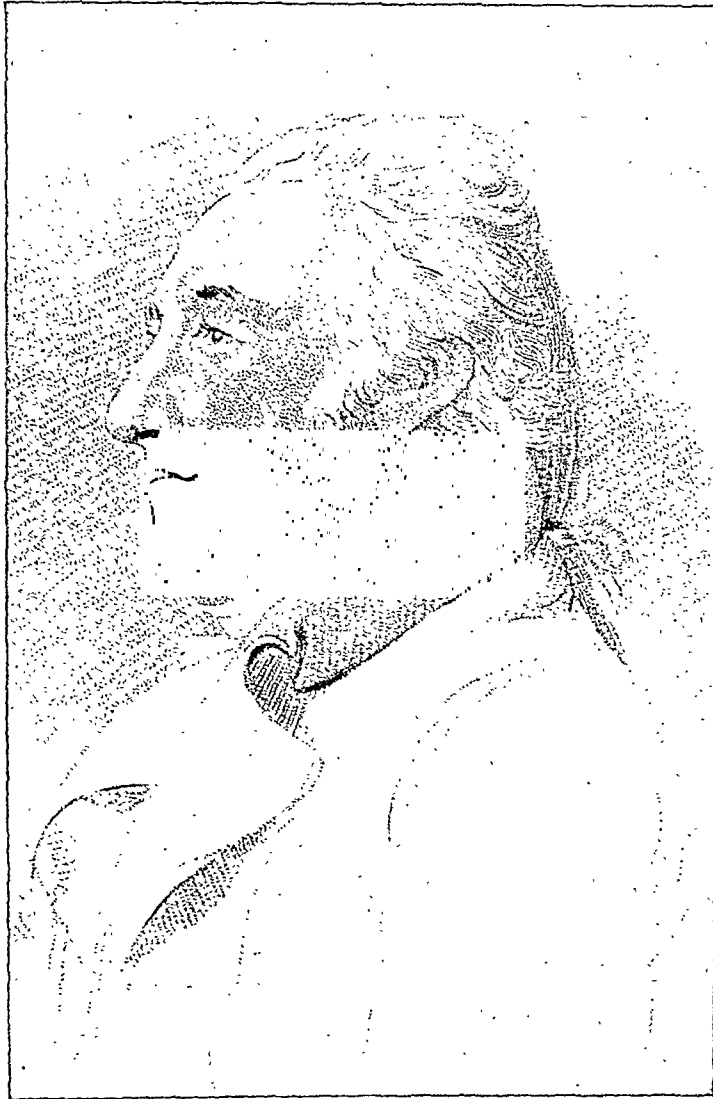
In 1788 he married Isabella Marshall of Philadelphia, who died two years later. In 1798 he married Elizabeth Mifflin. By this marriage there were several children.

Wistar played an active part in the cultured society of Philadelphia. "His house was the weekly resort of the literati of the city of Philadelphia." In 1813 he was the successor of Benjamin Rush as president of the Society for the Abolition of Slavery. In 1816 he became president of the American Philosophical Society.

Caspar Wistar died in Philadelphia on January 22, 1818.

T. S. W.





CASPAR WISTAR

[1760-1818]



[From Fernelius' *Universa Medicina*, Geneva, 1679.]

BOOKSHELF BROWSING

THE RENAISSANCE AND SERVETUS

BEN WOLEPOR, M.D.

MONTREAL, CANADA

THE RENAISSANCE

THE Martyrs of Rodin walk in a magic circle, totally unaware of each other; a band of mystics laden with chains that would bind them to the earth they ignore. The noose encircles their necks, but they forge on relentlessly, grouped in a solidarity that confounds mankind. Several stare at the heavens; others regard the ground, but it is with a veiled glance, for their thoughts lie deep within. They are the dreamers who would bring heaven to earth although the road they traverse leads to the scaffold. They have been burnt by slow fire, stoned by the mob and broken on the wheel, but they renew their numbers miraculously and each age sees their successors. They are truly the sons of God. A valiant physician, Michael Servetus, was one of them.

Farel accompanied him on the death march, trotting amiably by his side; the honest, stupid Farel who innocently asked Servetus, "Why do you cry, 'My God, My God?'" To whom Servetus turned bewildered eyes and said, "On whom else shall I call?" Farel was Calvin's friend and the latter had plotted Servetus' death. He succeeded in making him

immortal. Farel turned to the crowd following Servetus and remarked, "He still calls on God; had he not been led astray he might have been a good man." When they reached the place of execution Servetus was bound to the stake by several turns of an iron chain; his neck was confined in a similar manner by rope. The crowd then reenacted a scene made memorable ages ago by crowning Servetus with a crown of straw and green twigs; for the hearts of men are slow to change. The torch was then applied and the darting flames reached for his face, drawing a cry of agony from the man. The crowd sickened of its sport and began heaping the faggots about Servetus, to hasten his death, but the wood was green and he suffered for half an hour, before death eased him of his pain and took him to regions where metaphysics are of little concern and men no longer torment one another because of divergent beliefs. His silence was broken once before death when he cried aloud to God to have pity upon him, but only the crackling of the flames responded.

The twentieth century finds difficulty in understanding the sixteenth. Four hundred years have placed a mighty, almost

impassable gap between the two. We have seen a boy fly across the Atlantic, observed railroads encircle the globe, sent expeditions into the Gobi to look for prehistoric man and unearth the dinosaur; watched aeroplanes dart about in the sun and have heard cannon hurl shells at Paris seventy-five miles away. New words have crept into the dictionary, Proletariat, Bourgeoisie; mighty nations are trying experiments that terrify mankind. Poverty, war is to be abolished. Men are forgetting heaven or else trying to bring it to earth. They no longer ask the number of angels that can stand on a needle point. They no longer believe in angels. They have gone into the discard with Apollo, Jove and Minerva. New gods have arisen, Production, Wheat and Cotton. Standardization is the cry of the day and the Machine rules. We know the planet which we inhabit, we have chartered its far-flung domains; it is no longer the thing of mystery and dread of the sixteenth century. We speak of relativity and light, economics and Babe Ruth. We feel enlightened and applaud Bernard Shaw but the sixteenth century would find us an earthy, alien crowd. They produced Erasmus and Sir Thomas More, Calvin and Servetus. They may have burnt the latter but he could never have been born in the twentieth century. The soil would have stifled him. We send our mystics to a sanatorium and an interne investigates their mental processes.

Servetus was a product of the sixteenth century, bearing the fruit of its advantages and disabilities. A brilliant physiologist, he refuted Galen in the realm of physiology and applied this fearless attitude to theology but found to his cost that faith was more important a factor in this sphere than critical investigation, and following the precepts of other institutions, the theologians destroyed the rebel who would undermine their structure. He was born of a distinguished family in Villaneuva, in the kingdom of Navarre, in 1509. His family had been jurists for generations.

He was built slenderly; his forehead was narrow at the temples but lofty, his eyes were those of the dreamer, the man who though he treads the earth, dwells on the stars. Realizing his inward bent, his parents sent him to a neighboring seminary, believing that his career was that of priest. Like so many others of the fraternity of genius, the boy was precocious and also preternaturally pious. He did not complete his course at the seminary because of his inherent rebellious spirit. It was not a matter of religious belief (he was to die of excessive piousness) but merely that of self-assertion. He would believe earnestly in God but in his own way and the sixteenth century regarded individuality in religious opinion as a crime worthy of death by fire; a death, which the dual personality of Servetus, made up of rashness and evasion, escaped for years only to fall victim at last to his foes.

A creed is not evolved overnight. It must undergo gestation and delivery before emerging upon the world. The beginning of the sixteenth century was a stormy period. The brewing of religious thunder was heard, which gathered momentum until the very skies rocked and blazed with the heretical denunciations of Luther. The Pagans had come back to earth and brought their gods. Minerva, Goddess of Wisdom, attended the Revival of Letters and the Renaissance ushered in the advent of the Reformation. The Renaissance depended in large part upon the revival of learning. The latter was due to the social progress of North Italian communities; accompanying zest for learning was a natural desire for aesthetic development. Patriotism drank deeply at the font of ancient Rome; grace, symmetry, fullness of spirit, emotional outlets were sought and found in ancient art.

The minds of men were restless; the medieval period was far from the dreary void it is pictured to be; fine minds were merely dormant, not dead, and they awakened from their prolonged sleep to seize eagerly upon the treasures of the past.

Hungry for spiritual exploitation, they seized the ancient treasures of Rome and entered into a fuller and riper world. The creed of asceticism was doomed. The body was no longer reviled as food for worms; it was a noble creation which had enchanted the ancients and was to bewitch the moderns. The age was ripe for conquest, and Petrarch, the leader of the Quattrocento, fell under the domination of Virgil. The finest spirits of the age yearned to absorb a whole glorious civilization, that of Rome; a consuming desire and one that was to spell the doom of the Middle Ages and to produce Erasmus, Voltaire, science and modern scepticism.

A poet, Francis Petrarch, was to be the dawn of a new age, that of intellectual enlightenment. The Medieval Church had stressed submission; the body was dust, its desires unworthy. Men marked time on this earth and only began to live when they discarded the earthly mold and entered Paradise. Teachers arose who were dis-sentient beings; who stressed the humanistic note. "Knowledge," they cried, "is only desirable in proportion to the use that can be publicly made of it." Social welfare was considered and not the isolated, human soul, enclosed in a cloister, intent on its own salvation. "Wisdom," they proclaimed, "must be broadcast and not hoarded."

Vittorino selected from ancient literature and moral teaching all that to him seemed ennobling. He stressed the Christian desire for inner harmony, yet included in his vast educational scheme the corollary of aesthetic satisfaction; sought for the tranquillity that results from the study of the beautiful in art and music; grace, trained activity was emphasized. A career, he felt, should be preceded by a broad cultural training; to acquire judgment, wisdom and integrity one must have the background of a liberal education, which the ancients alone could impart. Christianity, the off-spring of Judaism, was to be mellowed and matured by an infusion of Paganism. The Greeks were just as important in the

scheme of things as the Hebrews. Socrates had treasures to impart of which Moses was unaware. Vittorino trained captains of worth, able ecclesiastics, distinguished teachers and administrators. His age did not see in him the destroyers of their taboos. He was, however, one of the militant band which was to plunge Europe into religious wars that would cause blood to flow like water and make both Goethe and Voltaire exclaim upon the wanton strife that arrested progress for generations. But birth is always accompanied by pain and mighty oaks fall so that saplings may reach to the light.

Guarius Veronese, another great teacher, felt that in the study of letters man would forge to higher things. His sojourn in Constantinople, the very center of Greek culture, his constant study of its ancient literature, gave him an impulse that was not to be denied. He became professor of Greek at the Studio of Florence and put manuals of Greek and Latin grammar into circulation. The influence of Guarius caused the evolution of a brilliant center of humanism, the University of Ferrara.

Leo Battiste Alberti held that wisdom should be strewn with full hands along the highroads of the world for all to gather according to their inclination and capacity. He was opposed to the doctrine of the body's worthlessness and to asceticism. "The chief virtue of the mind," he cried, "is a restless curiosity, a desire to absorb truth consequential to this factor." "Man," he claims, "differs from the beast because of his insatiable desire to know the cause of things." It remained for Rudolph Agricola to transfer the torch that cast a brilliant light, from Italy to Northern Europe. The shadows were dark but the flame of learning would dispel them. A brilliant star was to appear in the sky; Erasmus, the tireless scholar who attacked the very citadels of faith amidst the clamoring of outraged monks. "You are destroying the church," they cried. "I am only correcting errors," he smiled. They knew what he was doing, this repre-

sentative of Lucifer, the arch rebel. They saw the handwriting on the wall and they could spell therein the names of Luther and Voltaire. Erasmus escaped the fate of the heretic because of his consummate cunning, the lore of an old fox. His friend, Sir Thomas More, said of him, "Erasmus quotes facts, he doesn't express his opinions." Thus the compeer of Reuchlin evaded the stake.

Reuchlin introduced the study of Hebrew and Greek into Germany and created modern biblical criticism. Erasmus, with the brilliancy and erudition that made him the friend of popes, Sir Thomas More and the distinguished circle of Englishmen that frequented More's home, steadily undermined medieval philosophy and scholasticism. The religious orders beheld his work with horror. They accused him of treachery, sought to imprison him in a monastery, but the bland Erasmus laughingly evaded them. He pointed the way but lacked the courage to follow the road that led where Truth beckoned; perhaps his wisdom, thoroughly grounded in the frailties of mankind, dissuaded him from action. He was the scholar and not the man of action. He did not believe that changing institutions would alter the inherent characteristics of man. He loved Mother Church and wished her to don garments as pure as they were in the days of her tribulation. He thought her aims a little too earthy and wished to purge her of her errors but did not wish to destroy her. He was in a most uncomfortable situation. Luther accused him of conservatism, the monks of being a pernicious radical. It was time for him to die. He had done his work and, like the spent servant, was no longer required. History will not forget Erasmus. He taught his generation to think. He introduced the scientific method of reasoning into biblical study and was thus a forerunner of the clear vision that actuates the scientist of today. He had substituted critical investigation for blind faith and was one of the apostles of Modernity. Freedom of thought was his creed. In a

letter to Cardinal Campegio he writes, "If we want truth, every man ought to be free to say what he thinks without fear." He did not know that his friend Sir Thomas More was to die because of the very Reformation that he had helped to create; the gentle More, one of the excellent products of the system that Luther condemned.

Sir Thomas More was the swan-song of the Church in England. He revered his time-hallowed creed and led a life that honored the faith he held. He was a man of sincerity and truth, conscious of his desires and the limitations of mortality. Had he yielded to his wife's practical advice and the suggestions of the daughter he loved, the wise Margaret, he would have avoided the headman's axe and the Church would have been denied a saint, but filled with the steadfast piety that renovates ancient creeds, he smilingly faced death. Luther did not know Sir Thomas More, he had not read his letter to Margaret that he wrote to her with a coal, while he was in prison. "Pecks of coal," he said, "would not suffice to express all his love for her." With that deep sense of humor that his portrait by Holbein shows, he urged his executioner to be brave. It is not recorded how he looked when his wife scolded him for adhering to a faith that was anathema. "I marvel," she said, "that you who hitherto have been taken for a wise man will now so play the fool as to be here now in this close, filthy prison, and be content thus to be shut up, among mice and rats, when you might be abroad at your liberty if you would do as all the Bishops and best learned of this realm have done." She was more verbose than Job's wife but the latter's, "Dost thou still retain thine integrity? Curse God, and die," still rings down the ages.

SERVETUS AND HIS CONTEMPORARIES

Into this web of devious strands spun by mortals, Servetus was cast. A spell had been woven by his age and Servetus, thinking he was a captain of his fate, was

only the agent of strong impulses circulating throughout Europe, subject, as are all men, to prevailing tendencies. When fourteen, he entered the University of Saragossa where a very liberal and talented teacher, Peter, Martyr de Angleria, influenced him. At Saragossa, Servetus learned the classics and acquired a smattering of Aristotle and scholastic philosophy, mathematics, geography and astronomy. He then went to Toulouse where he studied law. Despite his failure to become a priest, the chief interest of Servetus was religion and at this university he became acquainted with the Scriptures. He soon became a critic, influenced by the Reformers, and felt himself at full liberty to give his own interpretation of what not only the Church but its doctrine, required. He showed the enthusiasm and self-confidence of the genius; the characteristics that have led many a gifted son to a premature grave. Man can recognize deviation. He is not skilled at differentiating eccentricity from the sublime and therefore condemns the irreconcilables impartially. Servetus overlooked the overwhelming fact that the Church had been laboriously created and maintained for fifteen hundred years; with pitiful confidence he sought to alter an institution that was ingrained in the minds and hearts of men, that was universal. He lacked the caution of Erasmus. The world would marvel at his "De Trinitatis" (the world which had stoned the prophets). The names of Luther, Calvin, Melanchthon appeared on the title pages of their books; his, Michael Servetus, would appear also. Was he not superior to the others in culture?

The "De Trinitatis" is a small book, yet one regards it with a feeling of awe. A man died so that this book might proclaim a message strangely modern, despite the Latin script in which Hebrew and Greek words flash barbarically. In a strange matter of fact tone, weighted with authority, Servetus attacks the very foundations of the Church he loves; again presenting as incongruous a spectacle as

Jeanne d'Arc before the seat of the Inquisition; Jeanne who maintained to the end that God spoke to her through the intermediary of the Saints and not that of the Church. On the first page of the book, the name of Michalem Servito figures prominently, even his alias, Reves, as though he would naively absorb all the glory that the tract would draw. The publisher's name is not seen. He was wise in his generation.

Bucer was so incensed at Servetus that he savagely demanded his disembowelment. Bucer was usually of a mild disposition but Servetus had the undesirable quality of antagonizing men. He attacked the established order, reviled the reformers and yet so guileless was his mind, that he often wondered deeply as to the cause of his enemies' antagonism. His lack of awareness of the situation may have been due to a nature that could not harbor vindictiveness and therefore failed to see it in others. Luther called the "De Trinitatis" "ein greulich böß Buch." He resented the attack on the Doctrine of Justification by faith. Daunted by the indifference of the German and Swiss Reformers, Servetus left Switzerland for Paris in 1532. He failed to understand why his brother reformers had spurned his overtures. He did not perceive that enthusiasm runs in a narrow groove and that in the eyes of Bucer he was as reprehensible as Judas, for did he not spurn the chief tenets of the new creed. He found that rebels punished rebellion and that the man without a party is an isolated being. Fearing Roman Catholic France, he assumed the alias of Villaneuve, from his native town Villaneuva. He lived for twelve years in Vienne, the town that has recently constructed a monument in his memory, a figure signifying Remorse. Under his false name he wrote and edited many works at Lyons. His employers entrusted important work to him, one of which was the Geography of Ptolemy. Here the overwhelming desire to air his vanity again marked Servetus and he

carefully informs his readers of the labor he has undergone on their behalf. "For days and nights have I labored at my task," he writes. He makes a pithy comment in this book on scrofula. "I have myself seen the king touching many afflicted with this disease but I did not see that they were cured." He was a keen observer and yet blinded by mysticism, an excellent physiologist, still an astrologist; a lover of truth although a hunted man, concealing his identity under a false name. How could one man be all these things? The only answer is that of Walt Whitman's; when accused of being inconsistent, the latter said defiantly,

Do I contradict myself?
Very well then I contradict myself.
I am large, I contain multitudes.

Genius resembles a precious stone and like the jewel contains many facets. The children of genius contain multitudes, the world. Like Jeanne d'Arc they can tend sheep, lead the French army to victory, hear Saint Michael and proclaim the rights of the individual. Judged by ordinary standards the genius is abnormal; regarded by appropriate methods he is inspired and unique. What but genius could have made Servetus proclaim in the darkness of the sixteenth century that all men have a right to express their opinions without fear of consequences; a statement which appears trite in the twentieth century with its Hyde Parks, but an alarming announcement in Servetus' time. Was not Huss burnt and did not More die because of intolerance?

At Lyons, Servetus met Dr. Champier who persuaded the idealist to study medicine, which was a lucrative means of gaining a livelihood. Medicine was held in ill repute by the sixteenth century and was mostly practiced by Jews and Moors. Servetus entered the college of Calvi and then that of the Lombards to study medicine. He was a fortunate pupil of Joannes Guinterus, Jacobus Sylvius, Joannes Fernelius and was associated with Andreas

Vesalius. He was one of Joannes Guinterus' two prosectors and prepared the subject for each day's demonstration. Vesalius, repudiating the authority of Galen, became the creator of modern anatomy. He found a kindred spirit in Servetus who revelled in demolishing icons. Fortunate indeed was the founder of practical physiology, the exponent of the pulmonary circulation, in his scientific associates. Without minimizing his ability at all, one cannot but reflect on the whims of Fortune that led a zealous theologian to travelling the bleak highroad of science. Sarah Bernhardt was once asked to what she attributed her fame; "Luck," she replied bluntly. One cannot evade the fact that it was luck that enabled Servetus to embrace physiology, after a chequered career, and that made him famous because of his discovery of a fact that he himself used only to support his theological views. Servetus did not realize the true import of his discovery and even if he had, he would have regarded it as trivial, as a manifestation of that divine force in which he was immersed and strove to describe. Physiology was just a milestone on the long road that Servetus traversed, towards a goal that promised spiritual exaltation and truth, a goal whose light was so intense that it blinded him to other facts of existence. Had he been told that Harvey was to appear, Withering to discuss digitalis, Pasteur to expatiate upon rabies, he would have listened absentmindedly and at the first pause in the conversation would have ardently discussed the meaning of the Hebrew word Adonai. He was a child of his period.

It is absurd to describe an age as religious in the sense that all men participate in the feeling of spiritual controversy that beset the leaders of the sixteenth century. Historians may at times take this false, biased view as though they were medical students who require a classification of disease without deviations. We know that tuberculosis attacks lungs, lymph glands, intestines, bone and kidneys; that many organs in the body suffer from its ravages, that its onset

may be acute or insidious, that it may simulate other diseases; result in arrest or death. How shall we define disease, a manifestation of life, a warring of elements, often the response of the body to an aggressive irritant. We devise classifications, knowing full well that they are temporary, incomplete; that with increasing knowledge a rearrangement is obligatory and that even when in full possession of facts, the judgment of the writer, at best an intangible and personal attribute, influences the scheme, making for fluidity rather than crystallization. We can only hope to give an approximate view of the situation. Thought, another manifestation of life, resulting in institutions, produces the same problem of attack to the historian, that disease gives to the pathologist. He can only suggest that certain tendencies existed; not that the heart of man has changed perceptibly, but that new difficulties, like so many permutations and combinations, have produced different results. Men in the sixteenth century strove for wealth, wrote poems, made war, loved, sickened and died. Only the few were interested in scholasticism. Many were content to plow the field, garner the grain, herd sheep, sail ships and pursue the daily round. They were too busy to indulge in disputation. The leaders of thought were the theologians. They poured the mighty rivers of their intellect into the narrow, immovable bed of religious controversy. They colored the era and their conspicuousness attracts the historian.

Joseph Guinterus in the preface of his "Anatomical Institutions" informs us that Michael Villanovanus, a distinguished litterateur and authority on Galen, assisted him ably. From his association with Guinterus, Servetus acquired the anatomical knowledge that enabled him to elucidate the mechanism of the pulmonary circulation. The book in which this important contribution to science was written was seen by only a few theologians and remained unknown to the world at large for a century and a half after Servetus'

death. Like most scholars, he was hounded by poverty and forced to become a teacher in order to gain a livelihood. He lectured on the geography of Ptolemy and the science of astrology; the latter science was a peculiar hybrid, composed of the nucleus of astronomy and the false belief of the influence that the stars exert on man.

The medical world in the early sixteenth century contained two hostile factors, the Galenists who swore allegiance to the Greeks, and the Averrhoists who docilely followed the precepts of the Arabians. Servetus, the friend of Champier, naturally admired the teachings of Hippocrates, to which his scholarly attainments added further zeal. Nevertheless, the independence of view which strongly characterized the man was manifested in the impartiality with which he accepts logical Arabian views.

After a quiet haven, which was brief indeed, Servetus again plunged into difficulties. A new enemy had arisen; not the healers of the soul this time, but of the body. The Medical Faculty of Paris, a body of men who were to be made immortal by the ridicule of Molière, now arose in arms against Servetus. They resented his false views of astronomy and their opposition was made more vehement because of his success. He was a fluent teacher and his lectures on geography and astrology had attracted a multitude. His vogue as a general practitioner was excellent, not that he did good work (his brother practitioners were fully aware of his deficiencies) but he gave the public what it wanted. He could cast a horoscope with the skill of the witch of Endor. The public at the time believed in witchcraft and would desert a bearfight, one of the most amusing of pastimes, to flock in to hear one Will Shakespeare and his three witches discuss the fate of Macbeth. He had become conspicuous; Michael Villaneuve of Paris was as prominent as Michael Servetus of Switzerland. He was summoned before the Medical Council, and was mildly told that he must be more respectful in the

future. They were very lenient and suggested that he was transgressing the boundaries of true science by dabbling in astrology, a disreputable sister of witchery. The Dean of the Council rebuked him several times personally. He was warned of the difficulties confronting him if he did not mend his ways. The stars were to remain in their spheres; their music to be heard by celestial ears and not transferred to mankind. They were not to play the unnatural role of consultants to doctors. One must not cast nativities or prescribe remedies according as to whether Venus or Jupiter was in the ascendancy. Here they attacked the very stronghold of Servetus' success. He was really sincere and truly felt that the planets influenced the physical condition of the ill. He resented their advice and became defiant, felt that he was misunderstood, disdained tolerant suggestion and indignantly proclaimed that his medical brethren would suffer for their opposition.

His threats left the medical profession undisturbed. They publicly accused him of being not only a fraud, but a talkative one. He resented this intensely and immediately began to write a pamphlet in which he scourged the tender parts of his opponents. When the doctors ascertained that this book was in the hands of the printers, panic overtook them. They could see with a prophetic eye a Molière in the offing, and did not care to see him preceded by a physician. One can withstand war by an unfriendly power, but internecine strife is disastrous. The Faculty of Physicians petitioned the Parliament of Paris to suppress the publication of this tract. They also insisted that the apostle of Divination, as they termed astrology, be forbidden to lecture on the stars in their courses. He was therefore summoned to appear in Parliament and explain his attitude. In the meantime the wily Servetus had had his pamphlet printed and distributed before the day he was to appear in court. The doctors found to their chagrin that numerous members of the profession

and laity had already received the tract and that Servetus had partially won the day. They resorted to other manoeuvres. If one could not trap the fox one could put strychnine in his food. They suddenly became religious and wailed that he was a heretic; "He is practicing," they cried, "judicial astrology." He was therefore summoned before the Inquisition as an enemy of the Church and rebel of its decrees.

The Inquisition, a form of third degree, that partook of the diabolical cunning of scholasticism and the savagery of the redman, held freedom of thought, both scientific and religious, in subjugation. One could think but not speak. There arose men who felt that life without honor was a worthless thing; they talked and their views spread. To crush this infamy the Inquisition was elaborated. If one heretic was caught, they tried to ascertain from him the names of his friends; if he told he would be burnt at the stake without the preliminary tearing apart of his limbs. If he kept silent, they had many ingenious devices to extract the truth or that which they considered the truth; the confirmation of their suspicions. The Inquisitors forgot their role, that of spreading the gospel of peace on earth and good will to men. It is true that they handed their victims over to the secular arm for torture, but in order to hear the words of guilt from the accused, they were forced, despite their better inclinations, to go into the torture chamber where they could more easily hear the confessions of agonized men. Familiarity blunted their finer senses and, without becoming aware of it, they became cruel. The butcher who slaughters lambs grows hardened to his task and blood to him becomes a red liquid. The inquisitioners became inspired and they evolved ingenious devices. They would proceed as follows: a rag would be put in a man's mouth; the pharyngeal end was moistened with water which produced an attempt at swallowing. Temporary strangling was the result and when the rag was removed it was

covered with blood. The act was then repeated; the poor unfortunate wretch would then plead guilty even to the murder of his own mother. Many other means of torture were in use but they all proved unavailing. Truth, as is her way will triumph. The Latimers and Cranmers were numerous and to them death was a more welcome thing than life without honor. France at this period had an established Inquisition although Papal inquisitors, usually Italians, with the sanction of the Holy See and the French sovereign, presided in the large urban centers. The civil tribunals of the realm were given the power to judge their decisions. The Inquisition found him innocent and his discomfited fellow-practitioners had to await the judgment of Parliament. He was condemned by this august body to cease the practice of divination, to destroy the pamphlets circulated and those in his possession, and to honor the members of the medical faculty. Servetus grew despondent. He had again met defeat; a man whose moods were volatile, now elated, then depressed, felt that he could no longer endure public ostracism and professional disdain. His main source of income was taken from him when he was forbidden to cast horoscopes. He therefore left for Charlieu. His genius for trouble again made him leave; so he departed for Vienne, where he lived in the precincts of the palace and under the patronage of the Archbishop, Pierre Paumier.

SERVETUS AND CALVIN

John Frelon engaged Servetus as editor. Frelon was a friend of Calvin and was a very learned and tolerant man. He did not know that Villeneuve was the dreaded Servetus. At this period Servetus entered into correspondence with Calvin. Frelon was the intermediary. Calvin in a letter to Frelon stresses Servetus' lack of humility. It seemed that God alone could convert the pugnacious scholar. Calvin despaired of mortal means. "He is a Satan," he cried, "who keeps me from my work." Servetus

knew that Calvin was the head of the Church of Geneva, but that knowledge left him unperturbed. He resented advice. He had written to him on transcendental dogma as though he were an equal; had aired doubts which Calvin had possibly suffered from and was trying to suppress. The latter knew that his opponent was learned, detested his subtle heretical arguments from which he would not budge, disliked his familiarity. Calvin was a great man, possibly he could not have been the great Reformer had he possessed a sense of humor, but he did not see how absurd his condemnation of Servetus' arguments were when he himself was a hunted man, a leader in the Reformation. The letters between both degenerated into abuse. It is claimed by zealous adherents of Servetus that Calvin plotted his death because of the former's insubstantial attitude. It was not Servetus' views they claimed, but his confidence in expressing them, his skill in conveying them, that antagonized and made a deadly enemy of Calvin. The latter also resented the failure of his efforts. Servetus was a Reformer, had asked for spiritual advice, had received the best available at the time, Calvin's, and yet had repudiated his suggestions. Calvin sent Servetus his great achievement, the "Institutions of the Christian Religion." The latter calmly refuted the chief tenets of Calvin's creed, blithely dissecting the laborious propositions and reducing them to absurdity, thus rending to pieces the very flesh of Calvin. The shafts he hurled into Calvin's vulnerable side were not enough. He proceeded to turn their barbed ends. He culled phrases from Scripture to minimize his opponent's views. The situation was unendurable. The suppliant had turned critic and the subject reviled the head of his realm. To the destructiveness of his logic Servetus added the luster of Holy Writ and Calvin gazed with horror on the returned copy of his "Institutions" freely annotated on the margins with Servetus' candid views. The opponent of the Pope turned to destroy the unhappy man who

like Lucifer defied God from Chaos. To a friend Calvin cried, "There is hardly a page that is not defiled with his vomit."

Calvin in deadly earnest now sought to encompass Servetus' death. Slow fire he objected to, but the sword would do. Anything, anything to rid the world of this monster, this vile heretic! A letter is still existent which compromises Calvin; through which posterity regards askant an otherwise great man, one who was really touched with the divine afflatus. Like David, who praised and worshipped God but forgot him when Bath-sheba strolled across her courtyard, Calvin sank to a sordid level in his encounter with Servetus. He had lost his sense of proportion and wrote to Farel saying, "Servetus offers to come hither if I approve; but I will not pledge my faith to him; for did he come, if I have any authority here, I should never suffer him to go away alive." There are mitigating influences in this quarrel. It would take a calm man to see his life work withered by the phrase which Servetus hurls at Calvin, "Thou unworthy and blasphemous individual who desecrates the works of God." Granted that Calvin was responsible for Servetus' death, it must be considered that the gentle Sir Thomas More, than whom no kinder man and merciful ever lived, approved of the death of heretics. Even Jeanne d'Arc, who had striven to save the English wounded at one time in her career, contemplated a crusade against the Infidel. Had not the Bible said that brother would kill brother and father his son, to perpetuate the true faith? They earnestly believed the words written ages ago. They did not know that conditions alter the very meaning of words which come down the centuries; that a word is merely a symbol of existing circumstances, which when they depart, leave the word a mere husk of its former being.

Calvin was the instrument of the change that his generation demanded. He made a hidden urge articulate and his combat with Servetus was one destined by the age. The naive Servetus thought that

man could be compelled by reason; felt that to pronounce the truth was enough and that all would hail his vision, but he too had to follow his Master to an early grave. Voltaire stresses the narrow bond that allies a man's weakness to his virtues. Calvin's flinty heart made him not only a bitter, unmerciful adversary but a man apathetic of this world's goods. He left a negligible amount of money after his death. It is true that Calvin's deliberate plotting to destroy Servetus is an abhorrent affair, but personal motives may be ignored. He was a product of an intensely religious period, not a tolerant age that pitied the Magdalene, not an age that would ask that he who was free of sin should cast the first stone, but an age that was imbued with self-righteousness and like the Pharisees felt that it must defend God, the Immortal, who had existed when man was as yet represented by a unicellular organism. It is unjust to regard Calvin the man rather than Calvin the symbol, the representative of a theological era. The age regarded heresy as a very grave error, not only from the religious, but the social viewpoint. Had not Servetus compared the Trinity to Cerberus, the three-headed guardian of Hades? Calvin may have been introspective, he may have realized that he was shattering a mighty faith but he did not want the destructive process to go too far. He regarded himself as a defender of God and his true faith as he conceived it. Protestantism was in a perilous state, fighting for its very existence in a rapacious world that would devour it. One could contend with Catholicism but civil war was fatal. The situation was similar to that of the Jews who had fled from Spain to seek refuge in Holland and peace to worship their God. Uriah and Spinoza were excommunicated not so much for their dissentient views, as that the Jews to protect the many sacrificed the few. They feared to antagonize the religious beliefs of the Christians, who tolerating peaceful Jews, would rise against them if they heard that they harbored dissenters.

One of the most intent students of Servetus, Henri Tollin, says of him that the moment of greatest intensity and joy in Servetus' life was when he discovered the beauty of the Bible. Ravished by its councils, he renounced the idle pleasures of this world, its sham honors, and fictitious glory, for the peace that lay within the Book of God. "Il n'a qu'une seule passion, Jésus." To gain access to Jesus and reveal him again to a world that had surrounded his unadorned phrases with a complicated tradition that sometimes obscured the Christ, was the object of his life. Any view that conflicted with his conception of the Son of God, he resented wholeheartedly and opposed with the vigor of a Spanish warrior. This is the crux of the situation. Around this orbit Servetus and Calvin revolved and clashed. Calvin in his own sincere, puritanical way believed that Servetus was the Devil himself, uttering wicked lies under the guise of erudition. Servetus, admiring Calvin's astuteness, nevertheless felt that he was not doing justice to the finer conception of Christ. The situation was intolerable to both. Eight years after Servetus' death, Calvin wrote a letter to the Marquis of Poët in which he definitely states his opinion of him, untinged by mercy, the cooling quality of the years of retrospection.

Honor, glory and riches will be the reward of your labor, provided that you do not make the mistake of permitting these zealous fanatics to remain in the country, who are arousing the inhabitants to unite against us. Monsters of that type should be suppressed, as I succeeded in doing with Michael Servet, the Spaniard.

Servetus would not admit that the Eternal Son of God was to appear as man but only that a man was to come who should be the Son of God. He was impressed with what we call the historical view of theology.

Oecolampadius writing to Bucer says:

I saw this week our friends of Berne who make their compliments to you and to Capito. They are very much offended with the book

entitled 'De Trinitatis Erroribus,' which some of them have seen. I desire that you would acquaint Luther that this book was printed out of this country and without our knowledge. Our Church will be very ill-spoken of unless our divines make it their business to cry him down. He wrests all the passages of the Scriptures to prove that the Son is not co-eternal with the Father, and that the man Christ is the Son of God.

We can thus readily see that the motives that actuated Calvin were not personal but dictated by necessity. To enable Protestantism to live, Servetus had to die. Calvin felt that enough was done when the roof of the Church was removed. Behold, this rogue wanted to tear down the walls!

To further illustrate the critical tendencies of Servetus' mind one need only quote the preface to the translation of the Bible by Pagninus. Servetus the editor says:

We are taught by that wise man Jesus, the son of Sirach, that the Hebrew tongue when translated into any other language becomes defective, and loses much of its meaning. It is obvious that the energetic spirit, emphatic expression, harmony, antithesis, allusions and the like are impaired by our translations. Therefore both ancient and modern interpreters, despite great care, have never fully realized the true import of the Scriptures; especially those, who being ignorant of the affairs and customs of the Hebrews, fall into error where the literal and historical sense is concerned; from which alone one can meditate on future events. I suggest again and again, Christian reader, to first learn Hebrew and then study diligently the Jewish history before you enter upon the study of the prophets.

The Song of Solomon has at times been interpreted as magnificent poetry, at others as a revelation. Servetus warned against this latter tendency; the Jews, he felt, were like other races; their prophets were men of the times, who despairing of prevailing tendencies, warned the recalcitrant race. "Do not seek," he urged, "divine revelations in phrases, which if

regarded in the light of contemporary events, become commonplace."

Servetus lives, not because he discovered the pulmonary circulation; he himself attributed little importance to that which our day regards as a splendid achievement. The age had commanded the discovery of this fact. There are other scientists who contest with Servetus for the honor of this achievement. He looked upon it as the idle product of an uneventful period in his life and informs us of this revolutionary event as a casual support for an abstruse theological view. The world at large is not interested in Servetus the doctor, but Servetus the man of vision and steadfastness, who would die for his views. Science and brilliant men, as inevitably as the day follows the night, could now proclaim facts that would adorn a new era. The Renaissance had given them birth.

Servetus sent a copy of his "Christianismi Restitutio" to Calvin. He tried repeatedly to recover it but failed. He had, however, another copy in his possession. The world at large remained ignorant of the existence of this book until Wotton in his "Reflections on Learning" revealed its presence. In the fifth book of the "Christianismi" Servetus, to illustrate a metaphysical assumption, utilizes the physiological fact that has helped make him famous. He informs us that the right heart sends blood through the pulmonary artery to the lungs, whence the pulmonary veins transmit the fluid, now become crimson, to the left ventricle. Harvey was to amplify this statement.

Calvin informed Cardinal Tournon, Archbishop of Lyons, that Servetus was a

heretic and was masquerading under the false name of Villeneuve. He was cast into the Vienne prison from which he escaped to Geneva; was recognized there and arrested at Calvin's command. The conditions in prison at that time were execrable. Servetus, now in his first stage of martyrdom, was covered with vermin and filth. He contracted an intolerable diarrhea and in despair wrote to the Council. Nothing, he claimed, had been done for him in the way of cleanliness and his plight was pitiful. He suffered from the cold, colic and vermin. . . . "For the love of God, Sirs, in pity or in duty, help me!" Even in the depths, reduced to desperate extremes, he could not forget his self-assurance and in his plea the word duty rings like a golden bell. The Council replied by pronouncing the death sentence. He requested an interview with Calvin which was granted. The latter and two of the Councillors entered the prison an hour before noon on that fateful day, October the twenty-seventh, 1553. Calvin's face bore the fixity of features carved in granite. The stammering, awkward cries for mercy that Servetus uttered left him unperturbed. The phrase, "The quality of mercy is not strained," did not exist in his vocabulary. "Servetus," he said, commenting upon the situation afterwards with a friend, "looked as stupid as a beast." The interview was over, but it was far from complete, posterity would finish it for both Calvin and Servetus. All hope gone, his manliness crept back to Servetus until it filled his very being and in the proud composure of the man that he was, he headed the procession to the stake.

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[For remainder of References see p. 136.]

BOOK REVIEWS

HISTORY OF SCOTTISH MEDICINE. By John D. Comrie, M.A., B.Sc., M.D., F.R.C.P. 2 Vols. Ed. 2, Published for The Wellcome Historical Medical Museum by Bailliere, Tindall & Cox, London, 1932.

This "History of Scottish Medicine" in two volumes, profusely illustrated and delightfully presented, was made possible by the enthusiasm and generosity of Sir Henry S. Wellcome to whom the profession is indebted for the Wellcome Historical Museum in London. Of course, every physician and surgeon is familiar with the outstanding names such as Abercrombie, Thomas Young, Robert Whytt, the Monros, Charles Bell and others. These volumes unfold a great many important milestones in medical progress that originated in the Scottish schools. Men, events, institutions and conditions are spoken of in a manner that will not only interest and entertain but also instruct medical practitioners and students along lines that hitherto have been sadly neglected.

The contributions of the Scottish schools to the advances of medicine at last are presented in a permanent manner that will create renewed interest and research in the history of medicine in various countries. Works like Packard's "History of Medicine in the United States" and Comrie's "History of Scottish Medicine" are distinct contributions to our medical-historical literature which will take their place as classic works of reference. An innovation in books of this kind has been adopted in this instance by the interesting side-heads throughout the book which make easy reference for readers who can easily refer to specific paragraphs. It is unfortunate that a wider margin was not allowed as these otherwise almost perfect volumes create an impression of skimpiness by having the side-heads run almost to the edge.

It is a distinct tribute to the author that he has succeeded in going into minute details without being boring. The use of small type has enabled the insertion of original quotations without interfering with consecutive reading by those who wish to skip certain matters.

Congratulations are due to Dr. Comrie, to Sir Henry Wellcome and to the publishers for this book.

THE LABORATORY IN SURGICAL PRACTICE. By E. C. Dodds, M.V.O., M.D., and Lionel E. H. Whitby, C.V.O., M.D. (Camb.), M.R.C.P. (Lond.), D.P.H. Vol. I of series on Modern Surgical Monographs, Ed. by G. Gordon Taylor, O.B.E., M.A., F.R.C.S. London, Constable & Company, Ltd., 1932.

This book in twelve chapters gives the various laboratory methods on which surgeons are today dependent for accurate diagnoses. Carefully arranged and well written, the book gives a concise insight on the subjects covered for the busy surgeon. Thoroughly practical and giving the elemental facts, the book is intended for the surgeon himself rather than for the laboratory worker. It will be found invaluable as a work of reference.

PHYSICIANS OF THE MAYO CLINIC AND MAYO FOUNDATION. Vol. II, Phila., W. B. Saunders Co., 1931.

This volume supplements the volume published in 1927 and brings up to the time of publication the biographies of men associated with the Mayo Clinic. It is an unusually important work of reference for those who have an appreciation of modern surgery and its history. The bibliography accompanying each author is of unusual interest. The inclusion of a large number of portraits lends a personal interest to the volume that is generally lacking in a work of this kind.

HANDBUCH DER GESAMTEN UNFALLHEILKUNDE. By Fritz König, Geh.-Rat Prof. Dr. Med. Würzburg, and Georg Magnus, Prof. Med. Bochum. First Three Parts. Stuttgart, Ferdinand Enke, 1932.

The first three parts of this splendid textbook fulfill the promise made in the preface that the work would be a complete reference and textbook of the most authoritative kind. The illustrations, some of which are colored, leave nothing to be desired and the text lives up to expectations. A more complete discussion must be left until the work is complete. It is now appearing in parts of about 150 pages each and will be complete in four volumes.

DIE SPEZIELLE CHIRURGIE DER GEHIRNKRANKHEITEN. Redigiert von Prof. Fedor Krause, 3 Bände. II. Band, Die epileptischen Erkrankungen, ihre anatomischen und physiologischen Unterlagen sowie ihre chirurgische Behandlung. By Prof. Fedor Krause and Dr. Heinrich Schum, Berlin, 2. Hälfte, Neue Deutsche Chirurgie, Begründet von P. von Bruns. Herausgegeben von H. Kuttner in Breslau, 49 b. Band, Stuttgart, Ferdinand Enke, 1932.

This interesting book is the second volume on surgery of the brain covering epileptic diseases and their surgical treatment written by Drs. Krause and Schum. It would be a work of supererogation to attempt to criticize this work which is destined to become a classic. Concisely yet completely, it covers the subject with a thoroughness that we have become used to in this remarkably well-edited Series. In 400 pages, the authors have succeeded in including the surgical procedures connected with this condition. Illustrations are profuse and the bibliography is almost appalling in its completeness. The neurological surgeon will find this book indispensable.

DYNAMIC RETINOSCOPY. By Margaret Dobson, M.D., London, Humphrey Milford, Oxford Univ. Press, 1931.

This little monograph on "Dynamic Retinoscopy" in nine chapters covers the subject completely. It will be of value to those interested in the subject.

DIE UBERLIEFERUNG DER HIPPOKRATISCHEN SCHRIFT. By Hans Diller. Philologus Zeitschrift für das klassische Altertum, Begründet von F. W. Schneidewin und E. Von Leutsch, Herausgegeben von Albert Rehn and Johannes Stroux, in München, Supplementband XXIII, Dieterich'sche, Leipzig, 1932.

This discussion of Hippocratic writings is done with the ideal German thoroughness. It is invaluable to the student of the classics and to the student of historical medicine. To be properly considered, this work would require a longer review than is feasible in the JOURNAL. Suffice it to say that any student

will do well to have this work at hand for continual reference in any consideration of the all important Hippocratic writings.

IKONOGRAPHIA UROLOGICA. Im Auftrage der Deutschen Gesellschaft für Urologie, Herausgegeben von Alfred Rothschild, Berlin, Victor Blum, Wien, and Friedrich Necker, Wien, IV. Lieferung. Berlin, Georg Stilke, 1932.

This is the fourth part of a serial publication by the German Urological Society on "Ikono-graphia Urologica." The pictures, as was to be expected, are perfectly splendid. Special credit must be given to the colored reproductions, in spite of which the price is extremely low. The four parts published to date, comprise 109 illustrations. The entire work, on completion, will be made into an atlas. There is probably no field in medicine that is more dependent on fine illustrations for the proper teaching of the subject than is urology. The German Society's publishers are to be congratulated upon the successful accomplishment of a very difficult task.

LEHRBUCH DER RÖNTGENDIAGNOSTIK (Text-book of Roentgen Diagnosis). By H. R. Schinz, W. Baensch and E. Friedl, with the collaboration of M. Holzmänn, A. Hotz, O. Jüngling, E. Liebmann, E. Looser, and K. Ulrich. Ed. 3, revised. 2 vols., Leipzig, Georg Thieme, 1932.

Before us we see the high-water mark in the ever-growing stream of radiological literature. This is truly a magnificent publication, complete in every detail of radiological diagnosis, profusely illuminated with nearly three thousand roentgenograms or drawings. The text leaves nothing to be desired, unless perhaps a little more mention of the important contributions from American sources, both in the text and in the bibliography, but this predominance of references to European literature is quite understandable. One seeks in vain for serious omissions in this beautiful work; but the commendable phases are so numerous and outstanding that criticisms fall flat. The publisher has done his work well, the text and the illustrations leaving nothing to be desired.

Volume I devotes only thirty pages to an introductory chapter on roentgen physics, a

commendably brief but valuable prefatory section. Many text books on x-ray diagnosis consume a large percentage of their pages in useless discussions and descriptions of obsolete apparatus and methods, and illustrations of instruments freely and fully described in manufacturers' catalogs.

Following this brief section on physics and instruments, the authors proceed to the most elaborate and authoritative roentgen diagnostic text in existence in any language, considering in order the skeleton (bones, joints, and soft tissues), the study of which fills the remainder of the 700 pages in the first volume.

The second volume concerns the thoracic organs, the digestive tract, the liver, pancreas, and the spleen, the urinary tract, and a final chapter on gynecology and obstetrics. An excellent index, most satisfactory in detail, terminates this monumental work.

TECHNIQUE DE L'OSTÉOSYNTHESE. By Robert Danis. Paris, Masson et Cie, 1932.

This monograph on the general treatment of fractures details the procedures which are employed in Dr. Danis's clinic. Among other things is shown a fracture table which apparently is very efficient in his hands.

The technique involves the use of wire as suture material both intracortically and transcortically, and he describes instruments for the placement, tightening and fixation of these sutures. He also describes an electric saw for bone graft work, tibial grafts being employed. The x-rays would indicate a high degree of success by his methods.

In the author's use of wire, he describes an ingenious method for obtaining traction in the line of hyperextension for destructive processes in the vertebral bodies either from fracture or disease, by inserting the wire through the spinous processes, after sufficient hyperextension of the spine has been accomplished.

TEXT-BOOK OF MASSAGE AND REMEDIAL GYMNASTICS. By L. L. Despard. With two chapters contributed by Hester S. Angove. Ed. 3, Humphrey Milford, Oxford University Press, 1932.

A new edition of Despard's "Text-book of Massage and Remedial Gymnastics" is always

welcome. In this instance, the work has been brought thoroughly up-to-date. In the opinion of the reviewer, this book maintains its previous standard as "the best book on massage in the English language."

EMERGENCY SURGERY. By John William Sluss, A.M., M.D., F.A.C.S. and John Walter Martin, M.D., F.A.C.S. Assisted by David Hart Sluss, M.D., F.A.C.S. and Camilius Bowen DeMotte, B.S., M.D., Ed. 5, Phila., P. Blakiston's Son & Co., 1932.

The fifth edition of Sluss' "Emergency Surgery" has grown to almost nine hundred pages and remains, as always, a thoroughly practical and up-to-date manual on a subject which is daily growing in importance. The authors have certainly succeeded in assembling in compact space the essentials of a very intricate subject.

MANUAL OF SURGERY. By Alexander Miles, M.D., LL.D., F.R.C.S. Ed. and D. P. D. Wilkie, M.D., F.R.C.S. Ed. and Eng., Volume II (*Extremities—Head—Neck*), Volume III (*Thorax—Abdomen*). Ed. 8, Oxford Univ. Press, 1931.

These two volumes complete the work the first part of which was reviewed in a recent issue. These volumes give the modern British viewpoint on the subject and are fairly up-to-date. While the illustrations leave much to be desired, it must be remembered that the work is published at a very low price.

A TEXTBOOK OF PSYCHIATRY. For Students and Practitioners. By D. K. Henderson, M.D. (Edin.), F.R.C.P.S. (Glas.) and R. D. Gillespie, M.D. (Glas.), M.R.C.P., D.P.M. (Lond.) Ed. 3, Humphrey Milford, Oxford University Press, 1932.

This is the third edition since 1927, a fact which bespeaks the success of the volume. This work is dedicated to Dr. Adolf Meyer, of Johns Hopkins, and both of the authors have had training both here and in England. As a modern conservative view of psychiatry, this book may be highly recommended.

DIABETES, ITS TREATMENT BY INSULIN AND DIET, A HANDBOOK FOR THE PATIENT. By Orlando H. Petty, M.D., F.A.C.P. With an introductory Foreword by John B. Deaver, M.D. Phila., F. A. Davis Co., 1931, Ed. 5, 231 pp.

Five editions since 1924 would indicate that this book has made a definite place for itself. It is a thorough, practical guide and perfectly safe to put in the hands of patients.

BOOKS RECEIVED

All books received by THE AMERICAN JOURNAL OF SURGERY are listed in this column as soon as possible after their receipt and this must be considered as adequate acknowledgement. Books that the Editor considers of special interest to our readers will be reviewed in a later issue.

BIOLOGICAL TRAGEDY OF WOMAN. Translated by Stephenie Ofental. N. Y., Covici, Friede, Inc., 1932.

CLINICAL STUDY OF THE ABDOMINAL CAVITY AND PERITONEUM. By E. M. Livingston. N. Y., Paul B. Hoeber, Inc., 1932.

DIATETIK BEI CHIRURGISCHEN ERKRANKUNGEN. By F. S. Lapp and H. Neuffer. Berlin, Julius Springer, 1932.

DISEASES OF THE CORONARY ARTERIES (MYOCARDITIS). By Don C. Sutton and Harold Lueth. St. Louis, C. V. Mosby Co., 1932.

DOCTOR EXPLAINS (THE). By Ralph H. Major. N. Y., Alfred A. Knopf, 1931.

HEFTE ZUR UNFALLHEILKUNDE. II. DER HEUTIGE STAND DER KNOCHENBRUCHBEHANDLUNG. By Moritz Borchardt. Berlin, F. C. W. Vogel, 1932.

KONSTITUTION UND VERERBUNG IN DER ORTHOPADIE. By B. Valentin. Stuttgart, Ferdinand Enke, 1932.

LEITFADEN DER KOSMETIK. By A. Buschke, Alfred Joseph and Werner Birkenfeld. Berlin, Walter de Gruyter & Co., 1932.

MAN AND MEDICINE. By Henry E. Sigerist. N. Y., W. W. Norton & Co., Inc., 1932.

METHODS AND PROBLEMS OF MEDICAL EDUCATION. Series 20. N. Y., Rockefeller Foundation, 1932.

MODERN TREATMENT—ANAESTHESIA. By W. Stanley Sykes. N. Y., W. W. Norton & Co., Inc.

PRACTITIONER'S LIBRARY OF MEDICINE & SURGERY. 2 vols. N. Y., D. Appleton & Co., 1932.

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TUMORS OF BONE. By Chas. F. Geschickter and Murray M. Copeland. N. Y., American Jnl. of Cancer, 1931.

UBER DIE NEURE ENTWICKLUNG DER CHIRURGISCHEN BEHANDLUNG DER LUNGTUBERKULOSE. By R. Nissen. Berlin, Urban & Schwarzenberg, 1932.

VARICOSE VEINS. By H. O. McPheeters. Ed. 3, Rev. & Enl. Phila., F. A. Davis Co., 1931.

VERBANDTECHNIK. By Franz Hofmeister and Otto Jungling. Ed. 4, Berlin, Urban & Schwarzenberg, 1932.

WILHELM CONRAD RÖNTGEN UND DIE GESCHICHTE DER RÖNTGENSTRAHLEN. By Otto Glasser. Berlin, Julius Springer, 1931.

YELLOW FEVER. By Henry Rose Carter. Baltimore, Williams & Wilkins Co., 1931.

ZEITSCHRIFT FÜR DAS KLASSISCHE ALTERTUM. By Albert Rehm and Johannes Stroux. Leipzig, Dieterich'sche, 1932.



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*Continued from p. 132.

PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D., AND LOYAL DAVIS, M.D.

SEVENTH INSTALLMENT

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CHAPTER XXIII

THE MEDIAN NERVE

In civil life injuries of the median nerve occur as the result of wounds produced by knife stabs; glass splinters; suicidal attempts by cutting the wrist; compression by a tourniquet, splint or cast; by prolonged compression in anesthesia or sleep; and by dislocation of the ulna or fracture of the radius. Injections of arsphenamine or other drugs may produce a partial or total paralysis. It is frequently involved in occupational atrophy and paresis. Likewise, cervical ribs have caused paralysis of this nerve. In the War lesions of the median nerve were observed by many to be second in number to the radial. They occurred chiefly as the result of gunshot wounds.

In contrast to the radial nerve, partial motor paralysis is often seen in incomplete lesions. The median nerve is remarkable for the frequency with which its injuries are painful. The cases may, therefore, be divided into the painless ones, complete and partial, and the painful ones.

MOTOR SYMPTOMS

When the median nerve has been divided completely or when all physiologic function has been lost, the hand inclines slightly to the ulnar side of the forearm. There is considerable atrophy of the muscles of the thenar eminence and the thumb is in the plane of the palm, producing the so-called "ape-hand" (Fig. 165). Pronation is incomplete and defective. When the forearm is flexed the patient supplements this defect by holding the elbow out. When it is extended he rotates the arm inward, and this results in passive pronation of the hand. Paralysis of the palmaris longus may be determined by palpation of its tendon at the bend of the wrist when flexion at the wrist is opposed. Paralysis of the flexor sublimis and outer part of the flexor profundus digitorum is manifested by

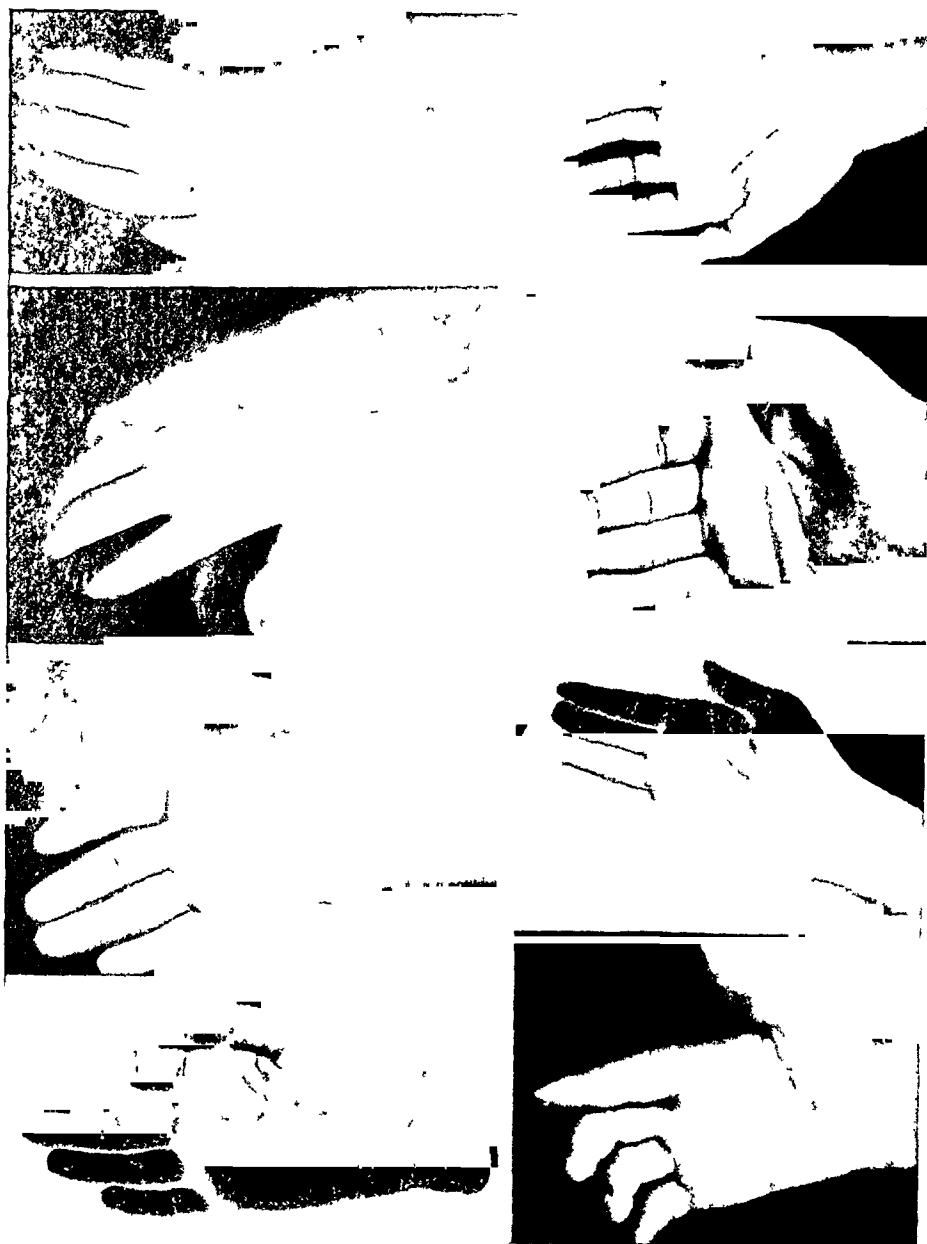


FIG. 165. Characteristic appearance of hands in median nerve lesions. Note ape-like appearance.

absence of flexion in the index finger and feeble flexion in the middle finger. This finger is usually influenced by the movement of the ring finger and at times the deep flexor may be

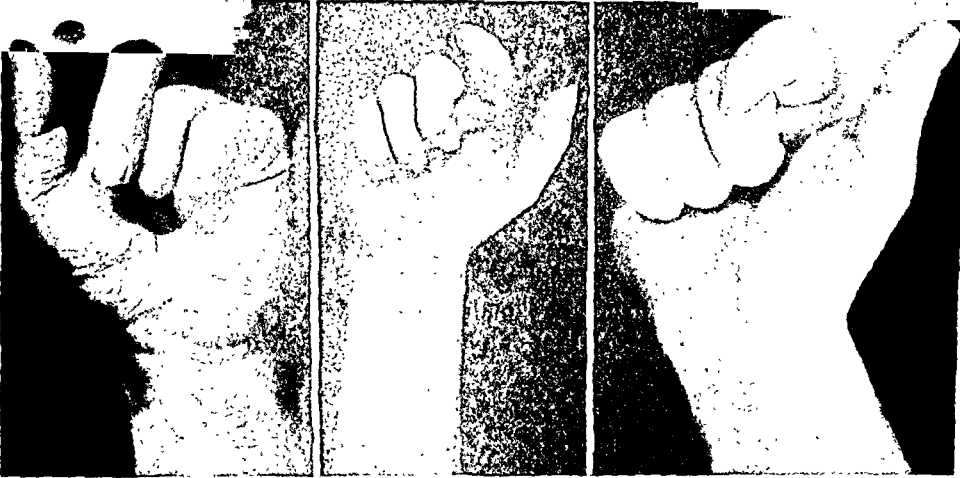


Fig. 166. Inability to make a fist in median nerve lesion.



Fig. 167. Inability to clasp hands in median nerve lesion.

supplied by the ulnar. These defects in flexion may be readily seen when the patient is asked to make a fist (Fig. 166). The



FIG. 168. Compare inability to oppose thumb and little finger in median nerve paralysis with that of a normal hand.

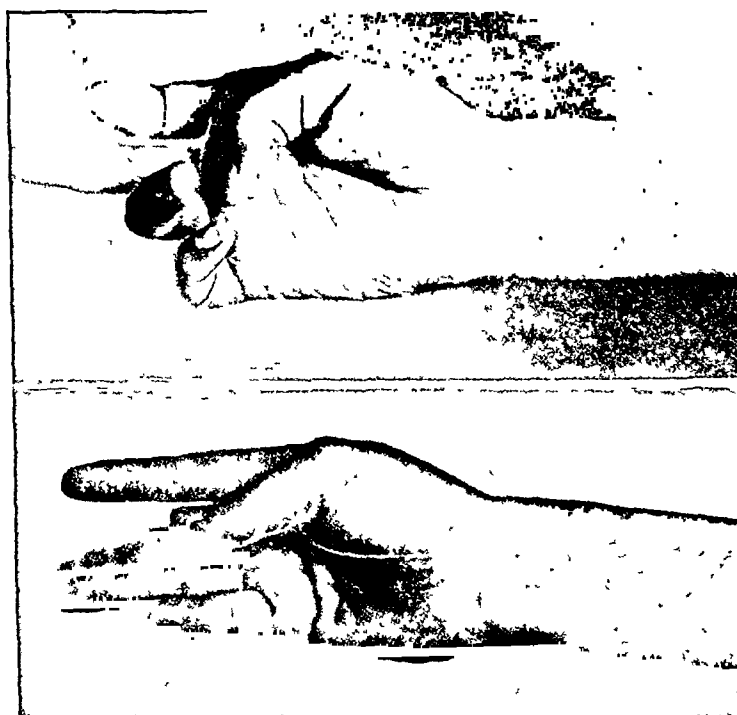


FIG. 169. Imperfect opposition of thumb in median nerve paralysis.

index and middle fingers will then be seen to have their phalanges only slightly flexed. The same defects may be observed by clasping the hands together as in prayer, when the index finger will remain extended (Fig. 167). Flexion of the proximal phalanges of the fingers may be carried out very well in spite of the paralysis of the lumbricales. Paralysis of the flexor longus pollicis makes it impossible to flex the distal phalanx of the thumb. Paralysis of the thenar muscles is shown by very defective opposition and abduction of the thumb at right angles to the palm (Figs. 168, 169).

SUPPLEMENTARY MOVEMENTS: In addition to the supplementary movements of pronation which have just been mentioned, others occur commonly in flexion of the proximal phalanges of the two outer fingers. The fact that the flexor profundus digitorum for the middle finger may in some instances receive its supply from the ulnar, explains the frequent presence of flexion of the first phalanx of that finger, inasmuch as the lumbricales have their origin in the tendon of the flexor profundus digitorum. If they are paralyzed, and especially if some contracture and shortening has taken place, contraction of the flexor profundus digitorum will produce a pull on the inert lumbricales and result in flexion of the proximal phalanges. That there is a pull exerted on the lumbricales seems to be shown by the fact that flexion of the proximal phalanx is stronger when combined with flexion of the terminal phalanges than when performed alone. The lumbrical muscle of the middle finger likewise receives its nerve supply from the ulnar. As was seen in paralysis of the extensors of the hand wherein flexion of the fingers produced a passive extension at the wrist, so under certain conditions the interossei may produce movements ordinarily subserved by the lumbricales. When extended the interossei produce a pull on the tendons of the flexor profundus and sublimis digitorum, and when the lumbricales are paralyzed, especially if these are shortened, passive flexion of the proximal phalanges will often occur. This mechanism permits full extension of the

terminal phalanges, and in median nerve lesions occurs in the middle and index fingers. It is to be noted that despite the paralysis of the flexors in a median nerve lesion, the position

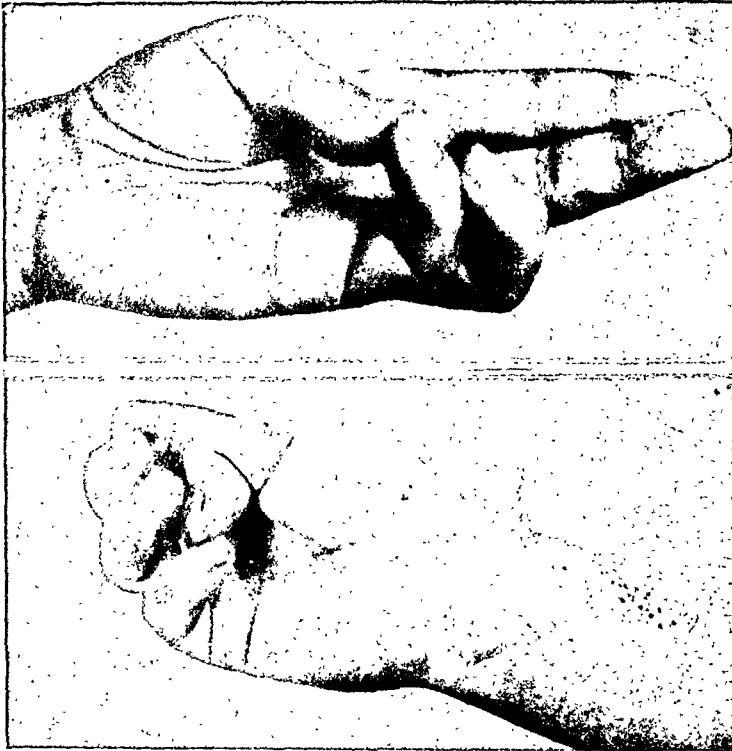


FIG. 170. Opposition of thumb in median nerve paralysis by supplementary muscle movements.

of the fingers is frequently one of flexion and not of extension. Flexion of the second phalanges of the two inner fingers occurs only a little weaker than normal as the result of the accompaniment of this movement to the normal flexion of the proximal and distal phalanges of these fingers. Flexion of the second phalanx of the middle finger is frequently present in this general flexor movement; first, because it is influenced by flexion of the ring finger and, second, because the flexor sublimis digitorum for this finger in some instances receives some of its nerve supply from the ulnar.

Flexion of the terminal phalanx of the index finger is always absent. Flexion of the terminal phalanx of the middle finger may be present in those cases in which the flexor profundus digitorum is supplied by the ulnar nerve. Extension of the wrist produces slight passive flexion of the fingers, which is better observed in combined lesions of the ulnar and median nerves. Flexion of the terminal phalanx of the thumb may be simulated by a rebound following extension of the phalanx. Opposition of the thumb to the little finger may be simulated by the action of the adductor pollicis combined with the inner head of the flexor brevis pollicis and flexion of the terminal phalanges of the little finger. It should be insisted upon that abduction, when tested, should occur at right angles to the palm (Fig. 170). When the metacarpophalangeal joint of the thumb is partially ankylosed so that no flexion or extension in the plane of the thumb is possible, traction of the extensor longus pollicis and the extensor ossis metacarpi pollicis produces abduction of the thumb at right angles to the palm.

SENSORY SYMPTOMS

The large overlap of the radial nerve to the palm explains the dissociation of loss to epicritic and protopathic sensibility in median nerve lesions. The area of loss to tactile sensibility and to milder degrees of heat and cold follows closely the anatomic distribution of the median nerve. It occupies the radial side of the palm, the palmar surface of the thumb, the index, middle and, at times, the outer half of the palmar surface of the ring fingers, and the dorsal surface of the distal two phalanges of the index and middle fingers (Fig. 171). After a period of about forty days the loss to pain and to higher degrees of cold and heat shrinks so that in general it may be said that the loss to pain may occupy only part of the second phalanges of the index and middle fingers. The exclusive supply of the median nerve to pain sense was found to occupy the dorsal and palmar surfaces of the distal phalanges of the index

and middle fingers, the ulnar half of the palmar surface of the second phalanx of the index finger, part of the ulnar portion of the distal half of the second phalanx of the middle finger

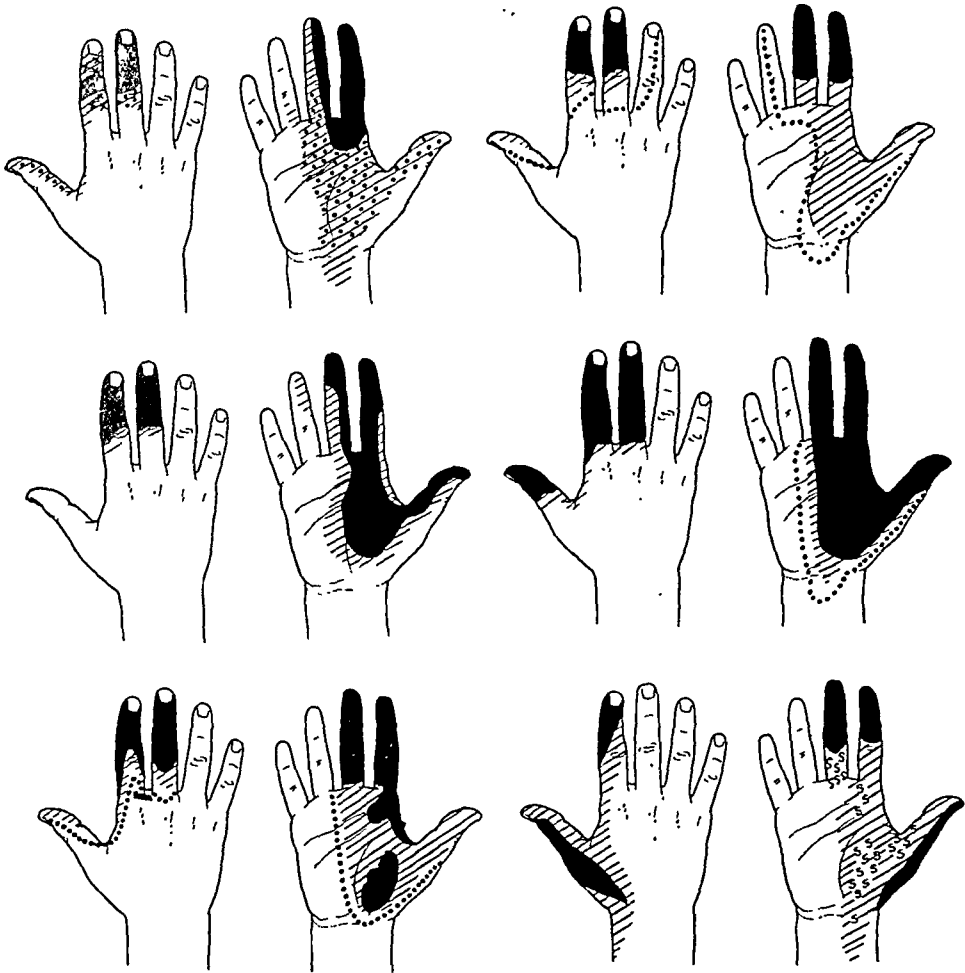


FIG. 171. Types of loss of sensation in median nerve lesion.

and the dorsal surface of less than half of the second phalanges of the index and middle fingers (Fig. 172).

The area of *residual sensibility* of the median nerve was obtained from cases of an ulnar and internal cutaneous lesion; a radial; a combined radial and median lesion; and cases of combined radial and ulnar lesions. The inner border on the

palmar surface was obtained by the method of residual sensibility from an ulnar and internal cutaneous lesion. On the dorsal surface we were compelled to employ another method

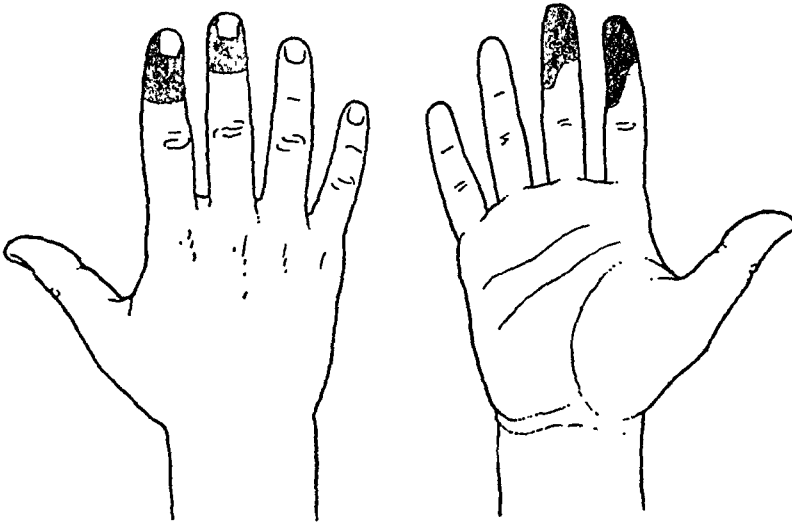


FIG. 172. Isolated supply to pain sense of median nerve.

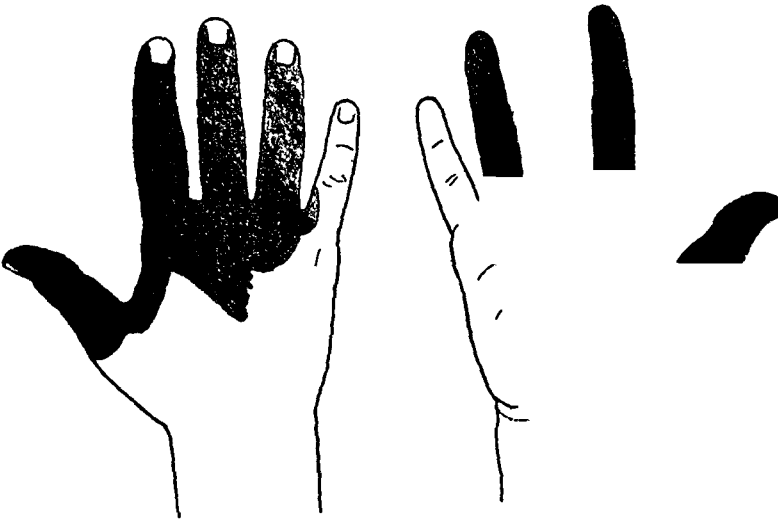


FIG. 173. Residual sensibility of median nerve.

since the cases of combined ulnar and radial lesions were too recent to have had return of prick pain due to overlap. The border of overlap of the musculocutaneous to the radial was

obtained by means of residual sensibility in a case of combined radial and median. Inasmuch as the radial has no isolated supply to prick pain, this border separates the musculocutaneous from the median overlap. We, therefore, used this border as the proximal border of the median overlap to the radial nerve. We were supported in doing this in those cases which showed an area of analgesia between the areas of overlap of the median and musculocutaneous nerves. Part of the inner border of the overlap on the dorsum of the hand is hypothetical and is shown as a rough border (Fig. 173).

Sense of position is often lost in the index finger and vibration sense is lost in the distal phalanges of the index and middle fingers. Because of the paralysis and the defective sensibility it is difficult for the patient to recognize objects placed in his hand. In complete lesions pinching the distal phalanges of the index and middle fingers never gives rise to sensation, whereas it is always produced in partial or incomplete lesions.

VASOMOTOR SYMPTOMS

The skin of the palm in median nerve lesions often is discolored, purplish, cyanosed, cold or red. The skin is dry and chapped and at times keratotic. Although Bénisty has never seen a case uncomplicated by vascular damage in which the nails showed any change, in our experience ridging and hypertrophic nail-beds were often seen (Fig. 174).

So-called trophic ulcers were commonly observed, especially on the distal phalanx of the index finger, where they usually occurred as the result of a burn by a lighted match. Once injured, the skin and subcutaneous tissues were sluggish in healing and ulceration resulted.

LEVEL OF THE LESION

A lesion of the median nerve in the middle of the forearm may paralyze the superficial flexor of the index finger while allowing those of the other three fingers to escape. The palmar

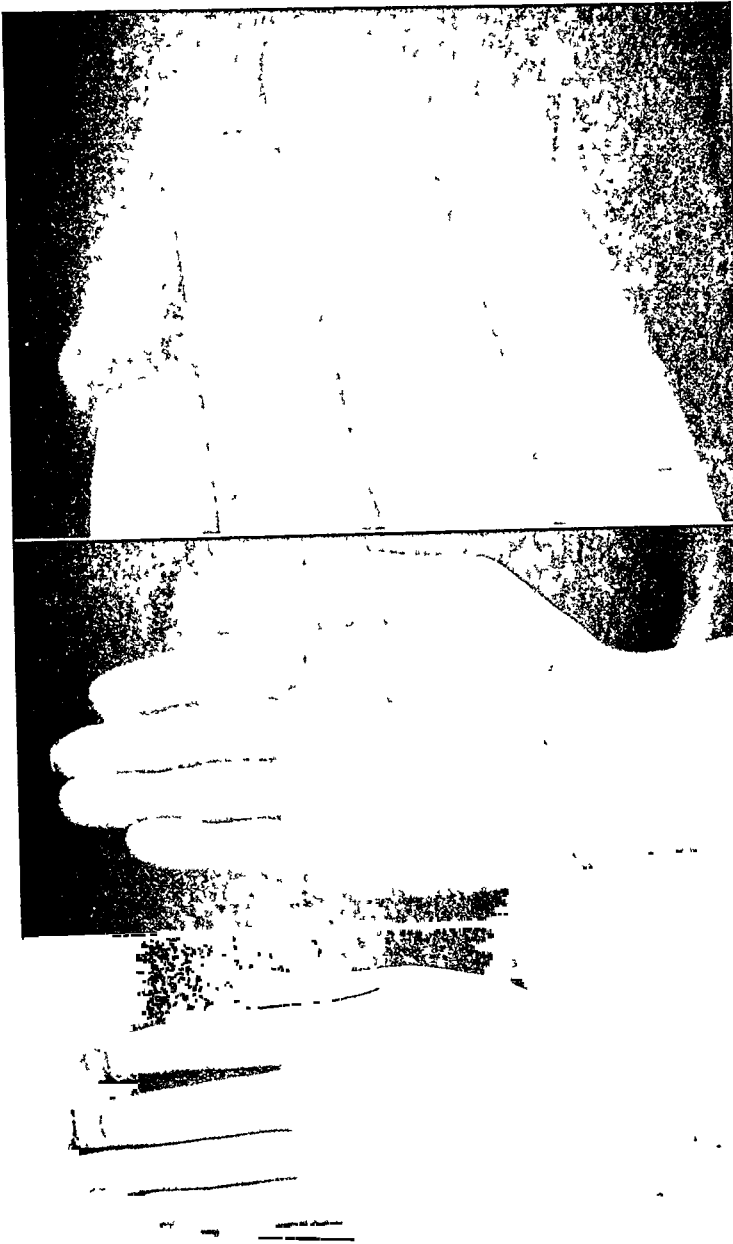


FIG. 174. Trophic changes in median nerve lesions.

muscular branch arises at the level of the trapezoid ridge, or the lower edge of the annular ligament. The highest branch given off from the median is that to the pronator radii teres in the outer cubital space.

PARTIAL LESIONS

Bénisty states that in partial lesions flexion of the index finger is the most defective movement, though opposition of the thumb is very poor as well. There is frequently imperfect flexion of the middle finger and of the second phalanx of the thumb. The pronators and flexors of the wrist are either not affected at all or are very slightly paretic.

Of 16 cases seen in the U. S. General Hospital No. 28 after injury of the median in the arm, the opponens was paralyzed in 8 cases; all were weak in 7 cases; the flexor of the thumb was paralyzed in 4 cases; the flexor of the index finger in 3 cases; and the palmaris longus in one case. Of 11 cases injured in the forearm, the flexor of the index finger was paralyzed in 5 cases; all muscles were weak in 4 cases; the flexor of the thumb, the abductor of the thumb and the opponens were paralyzed in 2 cases each, and the palmaris longus in one case. As in Bénisty's material, when dissociated paralysis occurred the flexor of the wrist was rarely affected. However, the opponens seemingly was more severely and more frequently affected than the flexor of the index finger in lesions of the arm. Further reference to this will be made under residual paralysis. In lesions of the forearm, the flexor of the index finger was more frequently involved.

In an analysis of the records in the Surgeon General's office representing all of the American material, of 59 cases of partial lesions in arm injuries, all muscles were weak in 33 cases; the small hand muscles were paralyzed in 9 cases; all muscles were paralyzed in 7 cases; the flexor of the index finger in 7 cases; the flexor of the thumb in 3 cases; the abductor of the thumb in 2 cases; the opponens in 2 cases; and the palmaris longus in one case.

Of 56 cases with injury in the forearm the small hand muscles were paralyzed in 31 cases; all were weak in 15 cases; all were paralyzed in 5 cases; the flexor of the index finger in 5 cases; the flexor of the thumb in 2 cases; and the abductor of the thumb in one case. It will be noted that the small hand muscles are most frequently paralyzed and next to them the flexor of the index finger. In lesions in the forearm paralysis in the small hand muscles is more frequent because the lesion is below the point where the fibers to the flexor of the fingers are given off.

Of 25 cases of partial lesions which were sufficiently severe to warrant operation in arm injury, all of the muscles were paralyzed in 9 cases; all were weak in 7 cases; the small hand muscles were paralyzed in 6 cases; the flexor of the index finger in 5 cases; the flexor of the thumb in 2 cases; the abductor of the thumb in 2 cases; and the flexor carpi radialis in one case. Of 17 similar cases of injury in the forearm the small hand muscles were paralyzed in 7 cases; all were weak in 6 cases; all were paralyzed in 4 cases; and the flexor of the index finger in one case. It will be noted that whether severe or not, the order of frequency of paralysis of certain muscles is the same.

Sensation is rarely lost completely in partial lesions of the median nerve, in contrast to ulnar nerve lesions. Unless complete physiologic interruption of function was present, the loss to touch and pain was coextensive, and when recovery to pain occurred touch sensibility likewise returned.

Physiologic interruption cannot be differentiated from anatomic section by the strength of the movements of the phalanges of the fingers. Although in a considerable number of cases the movements of the index fingers were stronger, this could not alone determine the character of the lesion. Return of function in the opponens pollicis would indicate a partial or recovering lesion, but because of supplementary motility it is difficult to determine.

Sensory regeneration or incomplete sensory loss in the area supplied by the median nerve is almost constant in

incomplete lesions and in otherwise physiologically complete ones; i.e., partial lesions sufficiently severe to come to operation. In a large proportion of partial or recovering lesions



FIG. 175. Marked atrophy in median nerve paralysis.

sensory regeneration is present when motor phenomena give no indication of regeneration.

ATROPHY

Marked flattening of the outer part of the thenar eminence is seen in the early stages of the injury, and after some months the group of muscles originating from the inner condyle likewise are atrophied. In the thenar eminences the head of the first metacarpal bone is seen prominently under the skin (Fig. 175).

SIGNS OF MOTOR RECOVERY

Bénisty believes that recovery of function of the muscles in lesions of the median nerve takes place in complete and partial paralysis in very much the same way. The pronator and palmar muscles regain their functional activity first, then the flexors of the middle finger and afterward the flexor of the thumb. Flexion of the index finger and opposition of the thumb are impaired for a very long time.

Stopford's statistics show that in 14 cases of suture of the median nerve in the lower third of the forearm the abductor brevis pollicis recovered first in 5 cases. Of 10 cases of injury

to the nerve at the bend of the elbow above the origin of the motor branches, in one case the pronator and flexor carpi radialis recovered first, and in 3 cases the abductor brevis pollicis. In 8 cases of suture of the nerve in the arm, the pronator, flexor carpi radialis and the palmaris longus recovered in one case and the abductor brevis pollicis in 3 cases.

From the Surgeon-General's material of 12 cases of injury to the nerve in the arm which recovered spontaneously, there was return of function in the flexor of the index finger in 7 cases; in the flexor carpi radialis in 5 cases; in the flexor of the thumb in 5 cases and in the small hand muscles in one case. Of 9 cases of injury in the forearm, there was return of function in the flexor of the index finger in 5 cases; in the flexor carpi radialis in 2 cases; and in the small hand muscles and abductor of the thumb in one case each. Following suture of the nerve in the arm in 15 cases, there was a return of function in the index finger in 8 cases; in the flexor carpi radialis in 8 cases; in the flexor of the thumb in 2 cases; and in the opponens in one case. Of 9 cases in which the nerve was sutured, there was a return of function in the flexor of the index finger in 4 cases; in the flexor of the thumb in 2 cases; and in the flexor of the wrist in one case.

The large number of cases which showed return of function in the flexor of the index finger may in part be due to an error because of misinterpretation of supplementary motility. Ignoring this muscle, it may be seen in these cases that the flexors of the wrist and of the thumb recover first. This differs from Stopford's figures in the few cases of recovery of the abductor of the thumb.

Further light may be thrown upon the problem in a study of residual paralysis. Of 18 cases of injury to the nerve in the arm residual paralysis remained in the flexor of the index finger in 11 cases and in the small hand muscles in 12 cases. Of 12 cases of injury in the forearm, residual paralysis remained in the small hand muscles in 8 cases and in the flexor of the index finger in 6 cases. It is evident that even if recovery does

begin early in the flexor of the index finger, it is very late in its completion. When recovery occurs in the small hand muscles the opponens is the last to recover (Fig. 176).

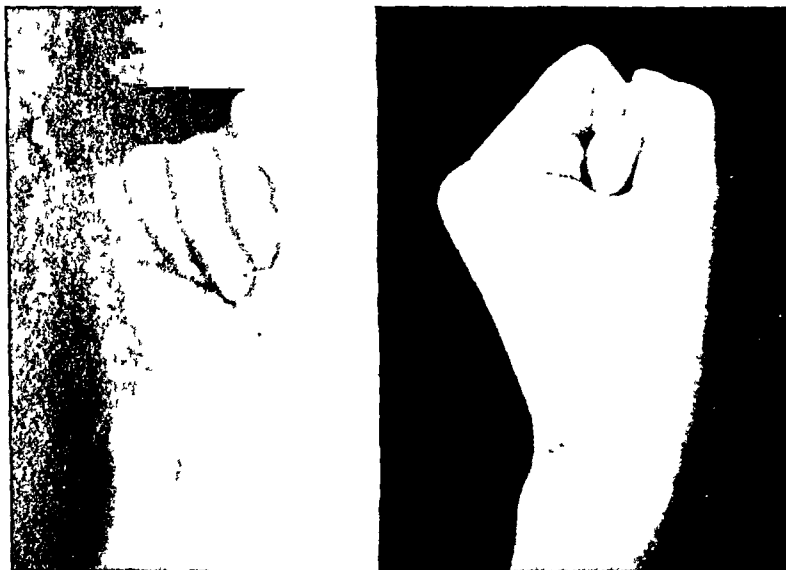


FIG. 176A.



FIG. 176B.

FIG. 176. Recovery of median nerve indicated by partially and completely clasp-
ing hands and making a fist.

Complete recovery of motor function may be tested further, as pointed out by Pitres, by having the patient scratch the

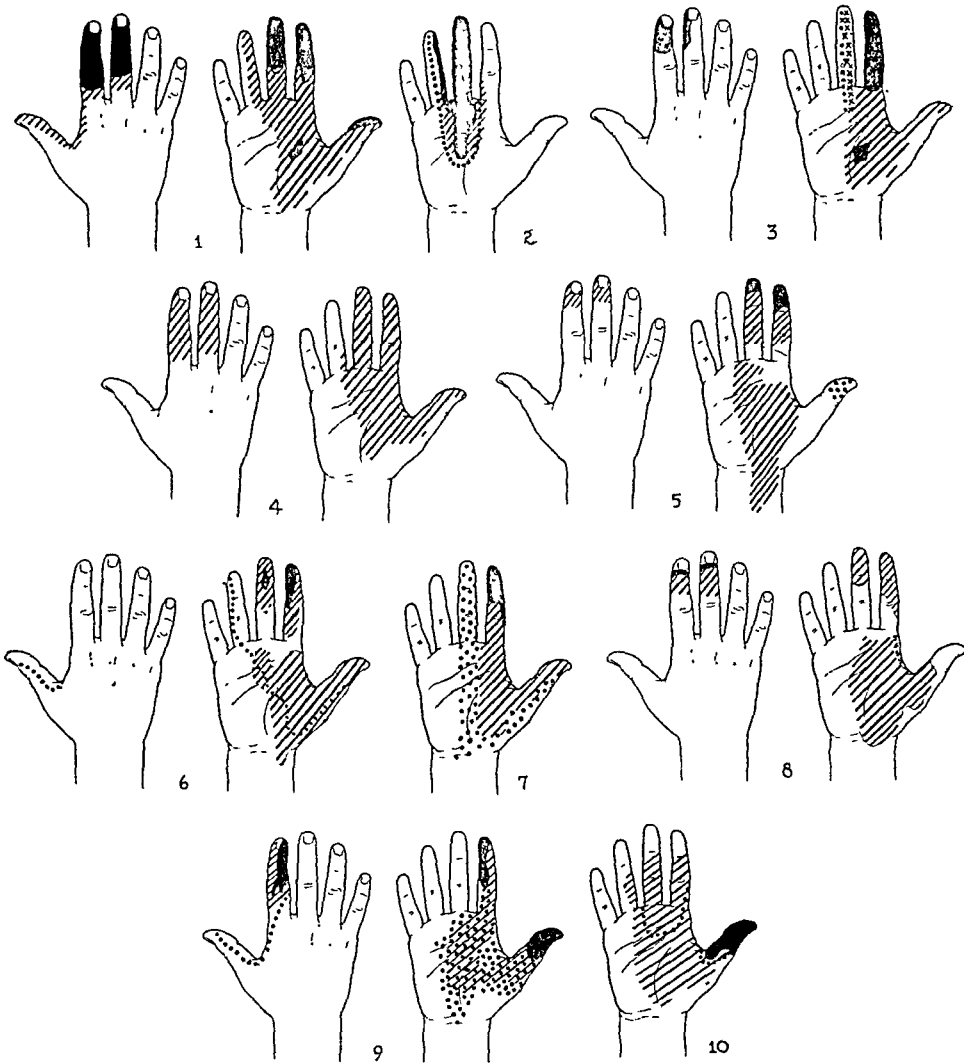


FIG. 177A.

A. Spontaneously recovering median nerve lesion. 1. Motor recovery, severe sensory loss. 2. Unusual distribution of sensory loss. 3. Recovery of touch but not of pain or cold. 4. Recovery of pain and cold, but not touch. 5 and 6. Patchy recovery of touch. 7. Recovery of touch and pain but not cold. 8. Patchy recovery of touch; complete recovery of pain and cold. 9. Recovery of touch and pain, but not cold. 10. Recovery of cold but not of touch.

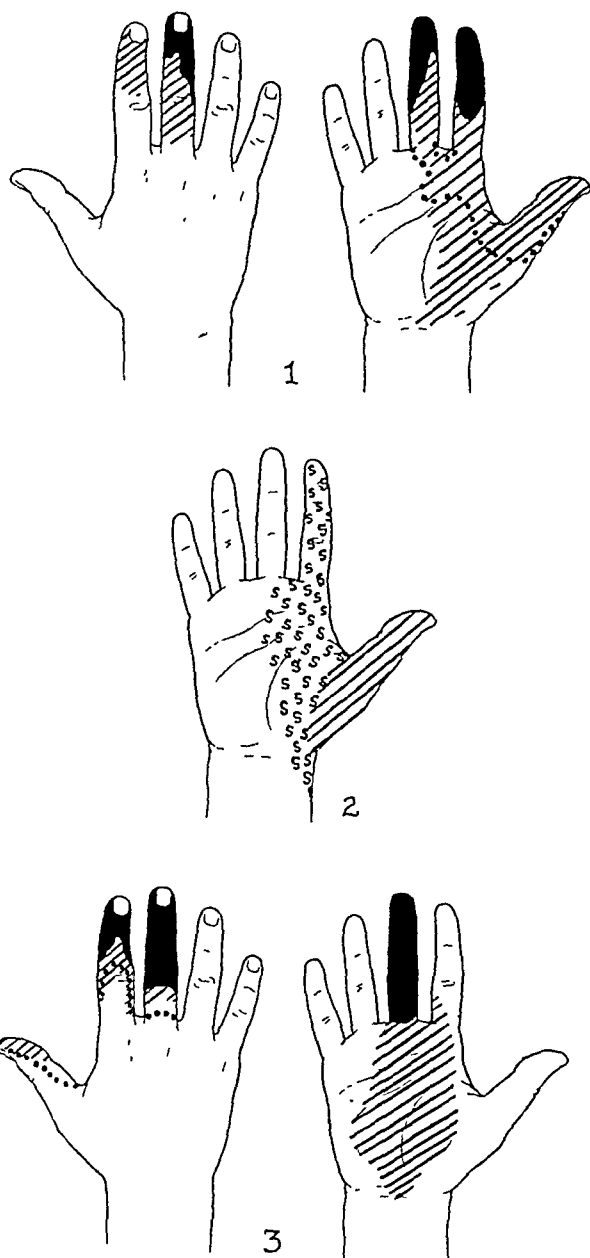


FIG. 177B.

B. Median nerve lesions after operation. 1. Slight interlacing of cold; recovery of cold, not touch; end-to-end suture. 2. Nodule excised, recovery of pain in isolated supply of nerve; diminished tactile loss. 3. Neurolysis, no analgesia or anesthesia of volar surface of index finger.

table with his index finger with the palm lying flat upon the table.

SIGNS OF SENSORY RECOVERY

The sensory recovery generally begins before motor function returns, but it remains defective for a long time, particularly in the index finger. In certain instances the return of protopathic sensibility has been interpreted as evidence of regeneration. This has led to the belief that the resulting "hyperpathic" sensations are a sign of recovery, whereas the opposite is true. After true sensory regeneration occurs the paresthesias and over-response to stimuli progressively diminish. On the other hand, when deep pressure is exerted over the area of isolated supply in the distal phalanges of the index and middle fingers, diffuse pain may be elicited during regeneration. In examining for Tinel's sign one may likewise evoke greater pain than in lesions of any other nerve. The same general observation, that interlacing of areas of sensory loss and return of sensation to any one or another type of stimuli in the isolated supply of the nerve is an indication of sensory recovery, holds true (Fig. 177).

Median nerve lesions which recovered spontaneously showed in a number of instances areas of return of sensibility to touch and not to cold. More frequently, cold had returned in areas whereas touch had not. Interlacing of the border of loss of cold was seen. Patchy return of tactile sense and pain sense was observed. Partial lesions often showed a sensory loss in only part of the sensory supply of the nerve. As a rule, the cases which recovered after operation showed less recovery to pain. When motor recovery had begun sensory recovery could often be seen.

PAINFUL LESIONS

A very large number of lesions of the median nerve are characterized by the predominance of pain. This painful type

of lesion was first noted during the American Civil War by S. Weir Mitchell, who described its intensity and character under the name of *causalgia* (Fig. 178).



FIG. 178. Causalgia in median and ulnar nerve lesion.

The motor disturbances are usually slight, and total paralysis of all the muscles below the level of the wound is of rare occurrence. However, some weakness in movement is always present. This is commonly localized in the flexors of the fingers but particularly the index finger and the thenar muscles. Much of the weakness is due to the pain, which is increased upon movement. Involuntary movement consisting of an irregular tremor of the thumb and index finger, but noticeable in all the fingers, is characteristic of these painful lesions, which are described in detail in the chapter on Causalgia.

DIFFERENTIAL DIAGNOSIS

At times a differential diagnosis may be necessary in civil life when paresis and atrophy of the muscles supplied by the median nerve may be the result of cervical ribs, syringomyelia

or other disease of the anterior grey matter of the spinal cord. In general, it will be found that all of the signs of a median nerve palsy will not be present. For example, preservation of the function of one of the muscles, as the palmaris longus, may be present, or the sensory loss present follows a root or cord segment distribution. On the other hand, there may be no sensory loss at all. In addition, signs not explainable by a median nerve lesion will be present, such as a Babinski sign or a contralateral analgesia of the trunk or body.

In the War, injury to tendons and muscles, painful joints, hysterical paralysis and "congealed" hands required differentiation. Several characteristic signs of motor disability always were present in median nerve lesions. The thumb was in a position in the plane of the palm; the thumb could not be opposed to the little finger so as to make the letter "O." When making a fist the index finger remained partly extended and the terminal phalanx of the thumb was not flexed. The same was true when clasping the hands as in prayer. In general, both in congealed hands and hysterical paralysis, electrical reactions are normal. Muscles are involved which are not innervated by the median nerve, and others which are so innervated are spared. The sensory loss, if present, does not conform to the anatomic distribution of the median nerve, and no area of overlap to painful sensibility is ever found. The borders of the sensory loss which is present shift with each examination.

ANATOMY

The median nerve has two heads of origin, one lateral and one medial, which unite at the lower border of the pectoralis minor muscle to form the main trunk of the nerve. The external head of origin consists of fibers derived from the lateral cord of the brachial plexus, which in turn consists of the anterior divisions of the fifth, sixth and seventh cervical spinal nerves. The medial head of origin consists of fibers derived from the medial cord of the brachial plexus which is made up

of the anterior divisions of the eighth cervical and first thoracic nerves. Thus all of the spinal nerves which contribute to the formation of the brachial plexus are represented in the parent trunk of the median nerve.

Most commonly the lateral head of the nerve lies lateral to the axillary artery and the internal head crosses it but many variations in this relationship and in the origin of the nerve may occur and most of them have been described. There may be a reduplication of the two heads of origin or a third root of origin may arise from the medial cord. Occasionally the heads of origin may not unite to form the median trunk until they have reached the middle of the arm or even as low as the elbow. The lateral head of origin may pass behind the axillary artery to join the medial head and Turner has described the opposite condition.

As the trunk of the nerve descends below the inferior margin of the pectoralis minor muscle, it is separated from the anterior surface of the subscapular muscle by the axillary artery. The nerve is in apposition to the anterolateral surface of the artery and Cruveilhier has called attention to the imprint of this relationship upon the posterior surface of the nerve. The musculocutaneous nerve with its two branches to the coracobrachialis muscle lies lateral to the median trunk. The ulnar is placed more deeply and lies medial to the median, between the axillary artery and vein. The pectoralis major muscle covers the nerve in front and the coracobrachialis partially hides it on its anterolateral surface.

As it leaves the axillary space the nerve crosses the anterior surface of the artery although it may lie behind it, run parallel to it or pass either lateral or medial to it. At this level the median receives nutrient vessels from the brachial artery. Anterolaterally the nerve is pressed close to the coracobrachialis muscle and it follows closely the internal border of the biceps. Medially, the nerve and brachial artery are covered only by the brachial aponeurosis and skin. This may form a veritable aponeurotic canal (Cruveilhier). (Fig. 179.)

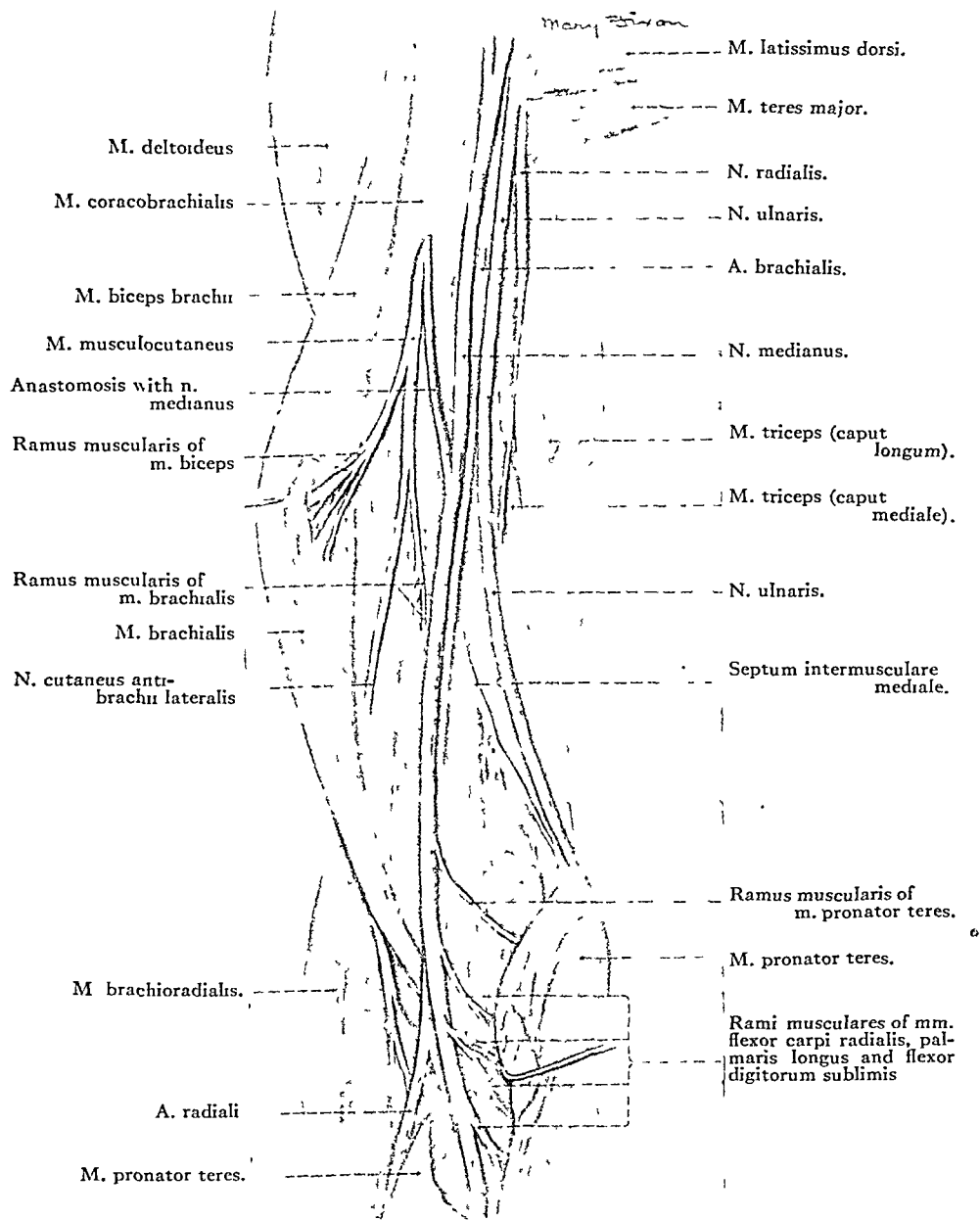


FIG. 179. Anatomical course of median nerve in arm.

Just above the elbow the median lies upon the anterior surface of the brachialis anticus muscle. It gradually leaves the brachial artery which comes to lie lateral to the nerve. The brachial aponeurosis and an extension of the aponeurosis about the biceps tendon covers the median anteriorly. The vein and the branches of the medial cutaneous nerve to the arm lie in the subcutaneous tissue superficial and medial to the nerve. The median then passes between the two heads of origin of the pronator teres muscle. The collateral branches of the brachial artery are intimately related to the nerve at this level.

In the forearm the course of the median actually justifies its name. It descends in the middle of the anterior aspect of the forearm in the fascial plane between the flexor digitorum sublimis and the flexor digitorum profundus muscles. As the ulnar artery passes from its site of origin from the brachial it passes posterior to the median in an oblique direction to reach the medial aspect of the forearm. As the tendons of the two large flexor muscles of the fingers arise the median lies directly upon the tendon to the index finger. The tendons to the middle, ring and little fingers lie medially and the palmaris longus tendon lies anteriorly. Hartmann has called attention to the fact that the nerve may be reduplicated in its course in the forearm (Fig. 180).

As the median approaches the wrist, it follows along the under surface of the flexor sublimis digitorum. It again becomes superficial, lying under the palmaris longus tendon, for which it has been mistaken commonly. The flexor carpi radialis tendon lies laterally. The median, contrary to the ulnar nerve, passes below the anterior annular ligament into the palm, where it lies beneath the palmar fascia. Here it divides into its terminal digital branches.

The median nerve gives off no branches in the arm except in the lower third near the elbow. A small branch may be given off to supply the elbow joint (Rudinger). Frohse and Fränkel state that this nerve may end within the brachialis

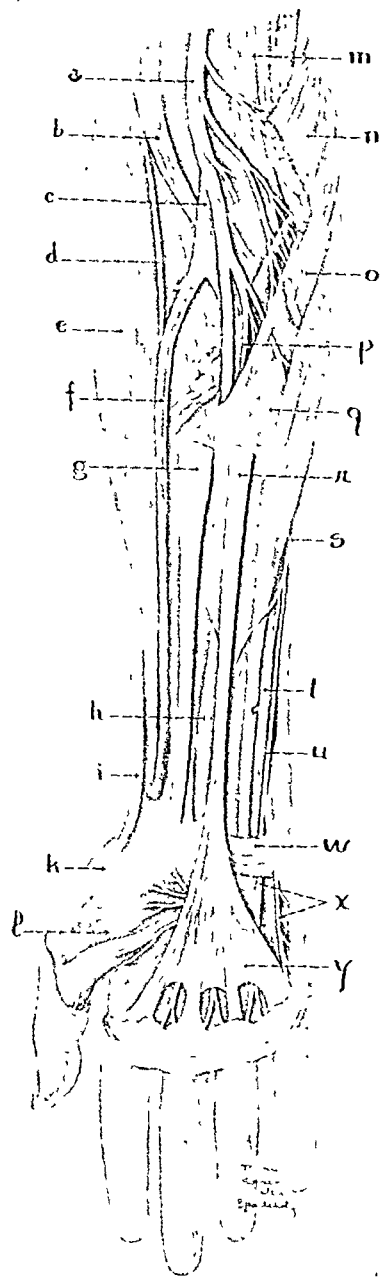


FIG. 180..Anatomical course of median nerve in forearm.

a, N. medianus. *b*, Tendon of *m. biceps*. *c*, *A. brachialis*. *d*, Ramus superficialis *n. radialis*. *e*, *M. brachioradialis*. *f*, *A. radialis*. *g*, *M. flexor carpi radialis*. *h*, N. medianus. *i*, *M. abductor pollicis longus*. *k*, *M. abductor pollicis brevis*. *l*, *M. flexor pollicis brevis*. *m*, *M. brachialis*. *n*, *M. pronator teres*. *o*, *M. palmaris longus*. *p*, N. interossei. *q*, *M. flexor digitorum sublimis*. *r*, Tendon palmaris longus. *s*, *M. flexor carpi ulnaris*. *t*, *A. ulnaris*. *u*, N. ulnaris. *w*, *M. palmaris brevis*. *x*, Ramus superficialis *n. ulnaris*. *y*, Palmar aponeurosis.

anticus muscle. Also at this level one or two branches may supply the humeral head of the pronator teres muscle. In many instances the median nerve communicates in a variable manner with the musculocutaneous nerve.

As the median reaches the antecubital fossa it gives off branches to the pronator teres muscle, usually three in number. They may be contained in a single sheath, dividing immediately before entering the muscles, after having a short extramuscular course.

The next branches given off are to the palmaris longus, flexor carpi radialis and flexor sublimis digitorum in that order. At about this level a branch is given off to supply the deep flexor group of muscles. It arises from the ulnar side of the dorsal surface of the nerve, descends in that position and gives off twigs to the flexor digitorum profundus muscle for the second and third fingers and to the flexor pollicis longus. This branch is known as the *anterior interosseous* nerve and is accompanied in its course by the anterior interosseous artery. It lies deeper than the main trunk in front of the interosseous membrane in the cleft between the flexor digitorum profundus and the flexor pollicis longus. It gives off additional branches to these muscles at a lower level. It ends upon the deep surface of the pronator quadratus muscle, which it supplies, and gives off a branch to the wrist joint.

A few centimeters above the anterior annular ligament the median gives off a palmar cutaneous branch. It arises from the lateral side of the main trunk, descends with it and sometimes is masked by it. It becomes quite superficial, passes over the anterior annular ligament and divides into a lateral and a medial termination to supply the palmar surface of the skin over the radial portion of the palm.

Just below the annular ligament the median gives off a muscular branch which supplies the abductor pollicis, opponens pollicis and flexor brevis pollicis muscles. Within the palm, the median divides into five terminal twigs which pass between the palmar arch and the flexor tendons. These

branches supply the skin over the radial and ulnar sides of the thumb, the radial and ulnar sides of the middle finger and the radial side of the ring finger as the digital nerves. These terminal branches also supply the first and second lumbrical muscles.

Hartmann, Longet and others have shown that the digital branches of the median give off collateral twigs which anastomose with the digital branches of the radial and form a real plexus about the terminal phalanges of the index, middle and ring fingers. Stopford has called attention to the fact that branches of the median innervate the interphalangeal articulations of the thumb, index and middle fingers. Cruveilhier, Sappey, Morel and Duval, Frohse and Fränkel among others have shown that there may be an anastomosis between the deep branch of the ulnar and the thenar branch of the median. Gegenbaur has demonstrated that the abductor pollicis may be the only muscle of the thenar eminence innervated by the median; the remainder receive their supply from the ulnar. Goldman, Auerbach and Brodnitz, and Stookey have called attention to the opposite condition, in which the innervation of all of the intrinsic hand muscles comes from the median nerve. The innervation of the lumbrical muscles may be irregular. Cruveilhier, Froment and Tumer state that the median may alone innervate the third lumbrical or it may receive branches from both the median and ulnar.

The median may have a branch of communication with the musculocutaneous nerve in the arm and with the ulnar in the forearm. The latter is said by Thompson to occur in about 15 per cent of 406 specimens. This may take place between the trunks of the two nerves; between the anterior interosseous nerve and the ulnar; between a branch of the median trunk, which arises near the elbow, passes over the flexor muscles arising from the medial condyle and the ulnar in its middle third; or by a communication between a branch of the median and a branch of the ulnar. The median may give a branch to the flexor muscles of the fourth and fifth fingers but the ulnar

nerve innervates the flexor muscles of the index finger. These anomalies of innervation and anastomoses should be kept in mind because they may help to explain certain clinical phenomena seen in the course of lesions of the median nerve.

PHYSIOLOGY

The muscles innervated by the median nerve have the primary physiological function described in the following paragraphs.

The *pronator teres* muscle pronates and flexes the forearm. The *pronator quadratus* also pronates the forearm strongly. The *flexor carpi radialis* flexes the radial portion of the hand but imparts to it no lateral movement. The *abductor longus pollicis* weakly flexes the hand. Complete flexion of the hand is accomplished by the coordinated action of all of these muscles. The *flexor sublimis digitorum* flexes the second phalanx upon the first, while the terminal phalanx remains extended. The *flexor digitorum profundus* flexes the terminal and second phalanges upon the first. Complete flexion of the fingers is possible only when the extensors of the wrist are fully contracted. Likewise the flexors of the fingers contract sharply but involuntarily when the wrist or fingers are extended voluntarily. The *flexor pollicis longus* flexes only the terminal phalanx of the thumb.

The *first* and *second lumbricales* act like the interossei into which they are inserted; they produce flexion of the first phalanges and extension of the second and terminal phalanges. The *opponens pollicis* flexes the first metacarpal on the wrist and at the same time draws it inward. The *abductor pollicis* and *outer head* of the *flexor brevis pollicis* produce a movement of the first metacarpal similar to that of the opponens. However, in addition, they extend the second phalanx and tip the first phalanx on its outer side, thus revolving it on its axis from without inward. Thus the tip of the thumb is opposed to the tips of the index and middle fingers. The *outer head* of

flexor brevis pollicis aids in opposing the thumb to the ring and little fingers. It tips the first metacarpal and the first phalanx of the thumb toward the little finger.

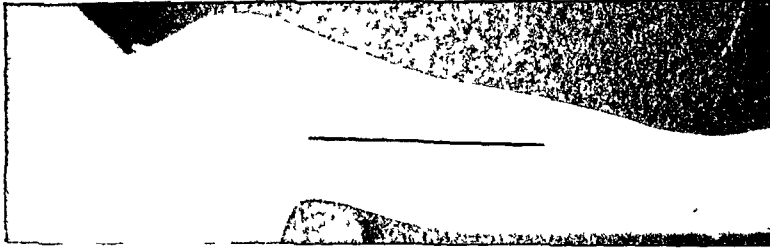


FIG. 181. Line of incision to expose median nerve in arm.

SURGERY

The median nerve like the ulnar is seldom injured alone in the axilla or upper arm. With the arm abducted and the forearm flexed, an incision is made along the medial border of the coracobrachialis muscle above the biceps below. If the extremity is extended fully, the median is placed upon stretch and in large, muscular individuals it may be hidden beneath the border of the biceps. If necessary the median may be exposed upward as far as the junction of its lateral and medial heads, by retracting the pectoralis major muscle (Fig. 181).

The axillary artery and vein commonly are injured with the median in the arm and care should be taken to prevent serious bleeding, particularly if the lesion is accompanied by a large amount of scar tissue. Torsion of the trunk of the nerve should be prevented here as elsewhere by placing identification sutures. The motor branch to the pronator teres muscle is the only structure which allows of an anatomic surface identification and this is utilizable only in lesions near the medial condyle. It is extremely important to visualize the antecubital fossa in attempting to expose the median at the elbow. The arm should be in abduction and external rotation with the forearm in complete supination. The base of the fossa is an imaginary line between the humeral condyles. Its medial wall is the lateral edge of the pronator radii teres muscle and its

lateral wall is the medial edge of the brachioradialis muscle. The biceps tendon passes through the lateral side of the fossa. The median nerve and brachial artery rest on the floor of the



FIG. 182. Line of incision to expose median nerve at elbow.

fossa which is formed by the brachialis anticus. To expose the nerve, one should identify the medial border of the biceps and its tendon. The median lies medial to these structures (Fig. 182).

A trifle lower the median passes between the two heads of the pronator teres and it is necessary to cut this muscle to expose the nerve adequately. This should be done very carefully to avoid injury to the motor branches which are given off at this level. The pronator teres may be divided near its humeral origin or at its tendinous insertion into the radius. In the latter case the radial nerve and artery must be isolated and injury to them avoided. After the pronator has been divided, the flexor carpi radialis is retracted medially. This exposes the flexor sublimis digitorum and its tendinous arch of origin which practically is the key to the operative field at this level. The median nerve and ulnar artery pass beneath this arch. The head of origin of the superficial flexor from the radius should be divided. The muscle may be retracted medially with the pronator and the median will be exposed in its entire length throughout its deeply placed portion upon the anterior surface of the flexor digitorum profundus. Injuries to the median at this level offer serious surgical difficulties because both the motor branches and the trunk may be

involved. Careful dissections and surgical conservatism are extremely important.

Exposure of the median in the forearm may be obtained

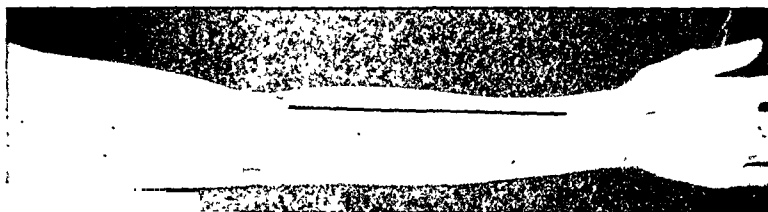


FIG. 183. Line of incision to expose median nerve in forearm.

by an incision from the medial side of the insertion of the biceps tendon in a line to the insertion of the flexor carpi radialis tendon (Fig. 183). At the junction between the middle and lower thirds of the forearm the median lies at a deeper level than it does at the wrist. It may be exposed by retracting the edge of the flexor carpi radialis muscle laterally. This will expose the aponeurotic medial edge of the flexor pollicis longus and the median lies in a cleft between this muscle and the flexor digitorum sublimis.

Lesions of the median nerve at the wrist are usually associated with division of the flexor tendons. Consequently great care should be used in identifying each structure. It is essential to identify the palmaris longus tendon and likewise that of the flexor carpi radialis. Little difficulty should be encountered in differentiating between the median nerve and the palmaris longus tendon. It is surprising, however, how often one finds the end of this tendon sutured to the end of the median. The tendon is more cylindrical, more compact and is of a pearly white glistening color. The nerve is dull and more grey in appearance. If this difference in appearance is uncertain, electrical stimulation will definitely help in the differentiation.

If difficulty is experienced in identifying the upper end of the nerve it may be of help to follow up along the edge of the flexor carpi radialis tendon. If the lesion is low it may be

necessary to divide the annular ligament and palmar fascia. The nerve may be identified as it passes along the radial side of the superficial flexor tendons. The anterior surface of

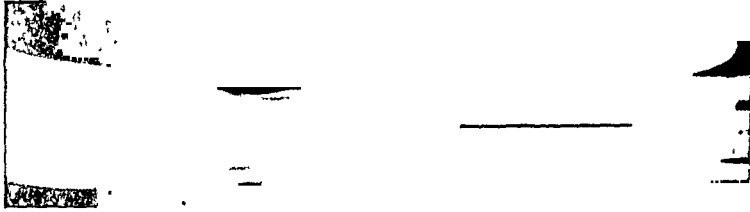


FIG. 184. Line of incision to expose median nerve at wrist.

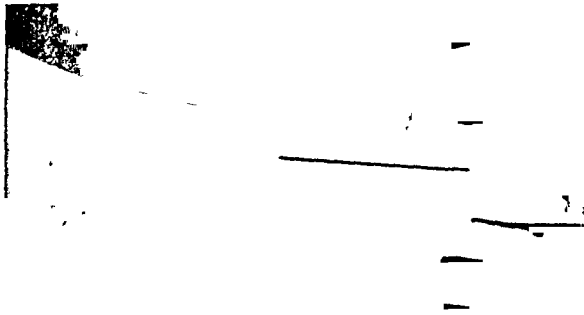


FIG. 185. Line of incision to expose median nerve in palm.

the nerve at the wrist frequently is marked by the small but distinct artery to the median nerve which passes along in its sheath. Prevention of axial rotation is as important at this level as elsewhere, even though the majority of the fibers are sensory in function (Fig. 184).

Exposure of the median in the palm may be obtained by an incision from the insertion of the palmaris longus tendon into the palmar fascia to the web between the index and middle fingers (Fig. 185). The palmar fascia must be divided and the flexor tendons identified. Near the wrist the median lies on the radial side of these tendons. The branches to the thenar muscles must be carefully preserved. The nerve passes below the superficial palmar arch and divides into its digital terminations. Only occasionally is it possible to effect a suture of these terminal branches. Suture of the nerve lower in the palm is

practical and may be accomplished with patience and exactness in dissection.

Continuity defects in the median nerve may be overcome in many instances by primary suture of the neuromatous ends and consequent stretching followed by secondary resection of the neuromas and end-to-end suture. Flexion relaxation of the elbow and wrist joints may bridge a considerable gap. The median may be transposed above the pronator teres, by carefully dissecting the motor branches free and isolating them to a point some distance above the medial condyle. A defect may be shortened 6 to 8 cm. by this procedure and flexion of the forearm.

Defects which cannot be bridged in this manner present a real surgical problem for repair. One may have to have recourse to autogenous grafts taken from the superficial branch of the radial nerve or to a suture between this nerve and the median. The results of such procedures are so unsatisfactory that it is necessary to use every effort to obtain an end-to-end suture. The incision may be extended into the arm or axilla in an attempt to obtain mobilization.

In concomitant tendon injuries at the wrist, each tendon must be isolated and both ends identified. They should be resutured carefully. If distortion of the original tendon patterns is necessary, then tendon anastomoses of similar physiological types should be made. The median nerve should be sutured after these steps have been taken.

TREATMENT OF CAUSALGIA

Since the pathogenesis of causalgia is not understood thoroughly, it is not surprising that the surgical treatment for the relief of this excruciating pain has been extremely varied and not uniformly successful. The information obtained by some of these attempts at surgical relief have helped to elucidate the pathology of this painful lesion.

Gosset operated upon several of the patients with causalgia in the service of Pierre Marie. In some instances the involved

nerve was slightly swollen or indurated and quite grey over a considerable distance. In other cases the nerve was found to be edematous and red or constricted by a rather tight fibrous band. Under these conditions the nerve was simply liberated but this procedure has no effect whatever upon the severity or course of the pain. In one case the swelling upon the nerve was torn apart and this was followed by complete relief of the pain within a week.

Sicard was the first to inject alcohol into the nerve trunk for the relief of causalgia. He recommended 60 per cent alcohol which he stated produces anesthesia but not paralysis. He reported twenty-one cases of his own; nine treated by Pitres; two reported by Gunda and seven by Godelewski, all of which were relieved by this treatment. Sicard injected about 3 cc. of 60 per cent alcohol with a very fine needle into the nerve trunk. The injection should be made 3 to 4 cm. above the lesion so that all collateral branches are reached. He states that in several instances pain was not relieved because the injection was made below or within the lesion. This procedure should be accompanied by the liberation of the nerve from all scar tissue and reconstruction of a new bed for the nerve. Pitres and Marchand have reported corroborative evidence to support this method of treatment. The strength of alcohol used for injection must be determined largely on one's decision as to how prolonged an action is desired. It is well known that the action of alcohol upon the fifth nerve, when it is injected for the relief of trigeminal neuralgia, is only temporary though absolute alcohol is used. Consequently it may be assumed that a peripheral nerve will recover its function proportionately sooner if 60 per cent alcohol is injected. If the pain does not recur with recovery of function then it may be assumed that some natural process of healing has occurred. It is therefore necessary that each surgeon judge each case individually to determine the percentage of alcohol to be used. Sixty per cent alcohol has produced motor as well as sensory paralysis in many instances. Reports are not infrequent, which

indicate that motor function has never returned after such injections.

Weir Mitchell's practice in the treatment of this condition was to section the nerve trunk. Pitres practiced this operation in a case of a painful lesion of the tibial nerve. The posterior tibial was sectioned at the level of the internal malleolus below the point of origin of the main muscular branches. This procedure relieved the pain in the sole of the foot. On the other hand, Sicard sectioned the median nerve 5 cm. above the lesion and resutured it immediately with only partial relief of the pain. As has been stated, Meige and Bénisty have emphasized the importance of involvement of sympathetic fibers of the large vessels or upon the small vessels within the nerve trunk or even the sympathetic fibers in the nerve trunk may be involved. In the belief that the pain is due to involvement of the perivascular sympathetic fibers, Leriche has performed a perivascular sympathectomy for the relief of causalgia and has reported successful results. Other surgeons have recorded less favorable results. Stookey removed the perivascular sympathetic from the brachial artery in a case of median causalgia but did not obtain a complete relief until he injected the nerve trunk with alcohol. The work of Kramer and Todd and Potts would tend to throw doubt upon this method of treatment. They have shown that the sympathetic supply of the vessels in the extremities comes from the adjacent nerves and is therefore segmented. In the arm these fibers arise from the musculocutaneous, ulnar and radial nerves. A localized perivascular sympathectomy such as Leriche performs would affect only a small area of the vessel so stripped. Our own experiments upon the peripheral pathways for sensation lead us to believe that there is no long unbroken perivascular pathway which transmits painful stimuli. While, therefore, this method of treatment is not anatomically sound the clinical reports of relief of pain by such an operation cannot be entirely ignored.

Lortat and Halley have reported a case of causalgia in the presence of section of the brachial artery and paralysis of the median and ulnar nerves. They ligated the median nerve with catgut and this was followed by a complete cessation of pain, vasomotor and secretory disturbances.

Many cases are upon record in which posterior root sections have been performed for the relief of causalgia. There are very few reports of successful results following this operation. In a recent survey of the literature upon the relief of pain in an extremity we have the impression that an insufficient number of roots have been sectioned.

Recently White has called attention to the possibilities of securing relief of causalgic pain by paravertebral injections of novocaine followed by alcohol. By such an injection an attempt is made to block the sympathetic rami. As yet, no results of this procedure have been reported in the treatment of causalgia.

As long as the pathogenesis of causalgia remains obscure it is obvious that no one surgical procedure may be recommended as the only completely successful method of treatment. At present it would seem that resection and suture of the nerve trunk above the lesion, as advocated by Weir Mitchell, is the most efficient.

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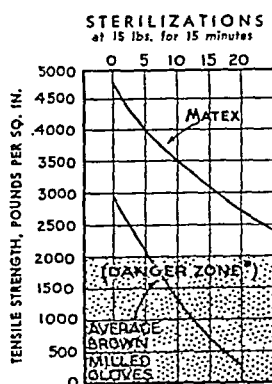
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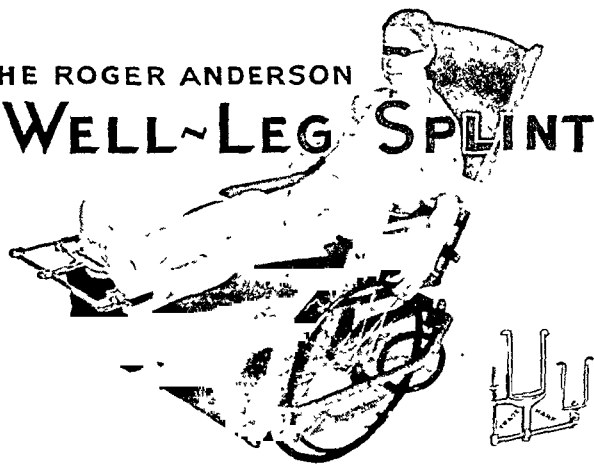
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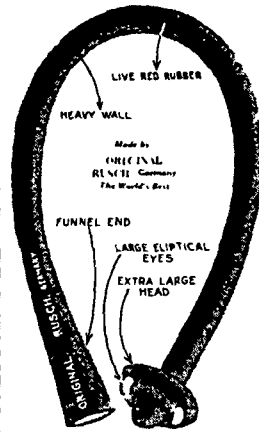
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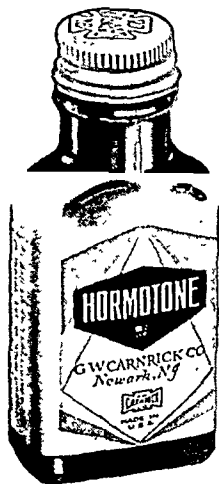
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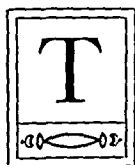
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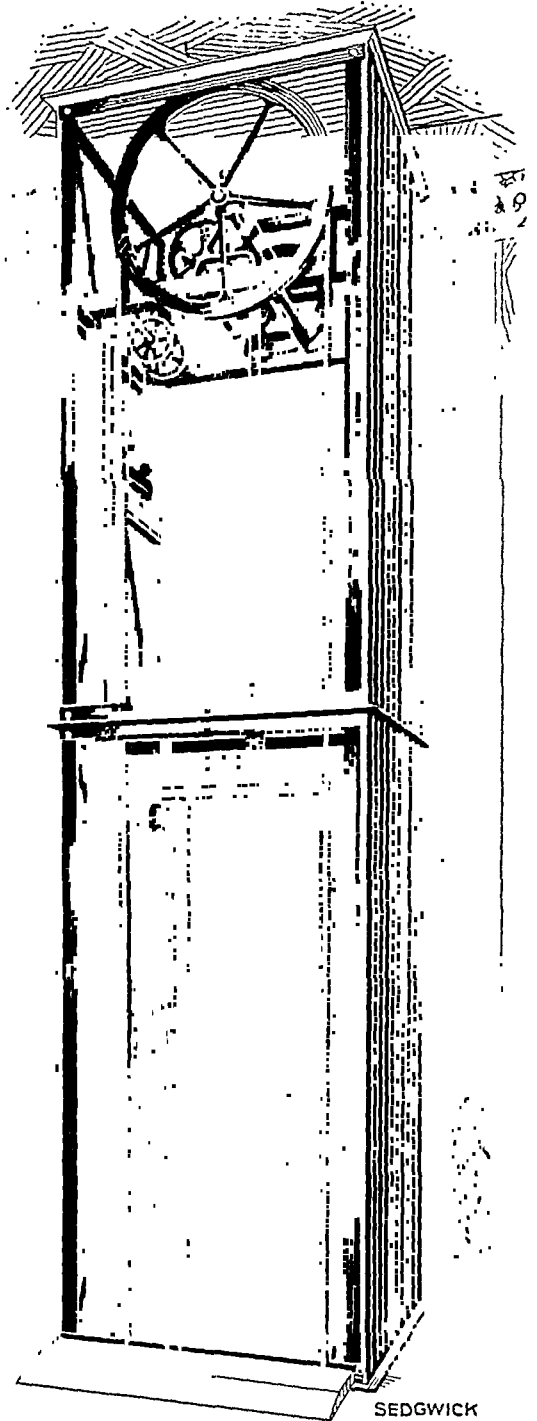
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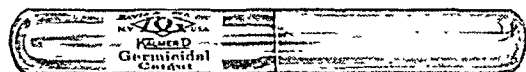
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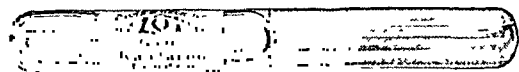
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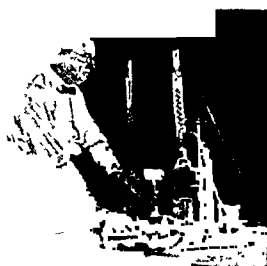


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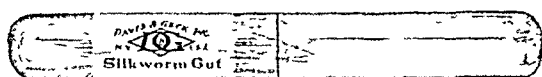
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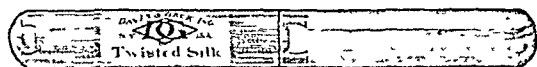


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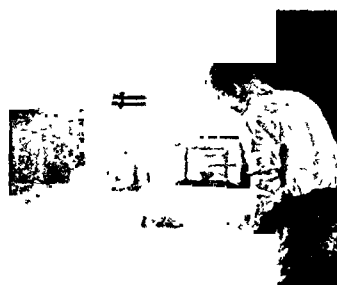
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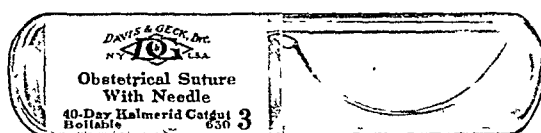
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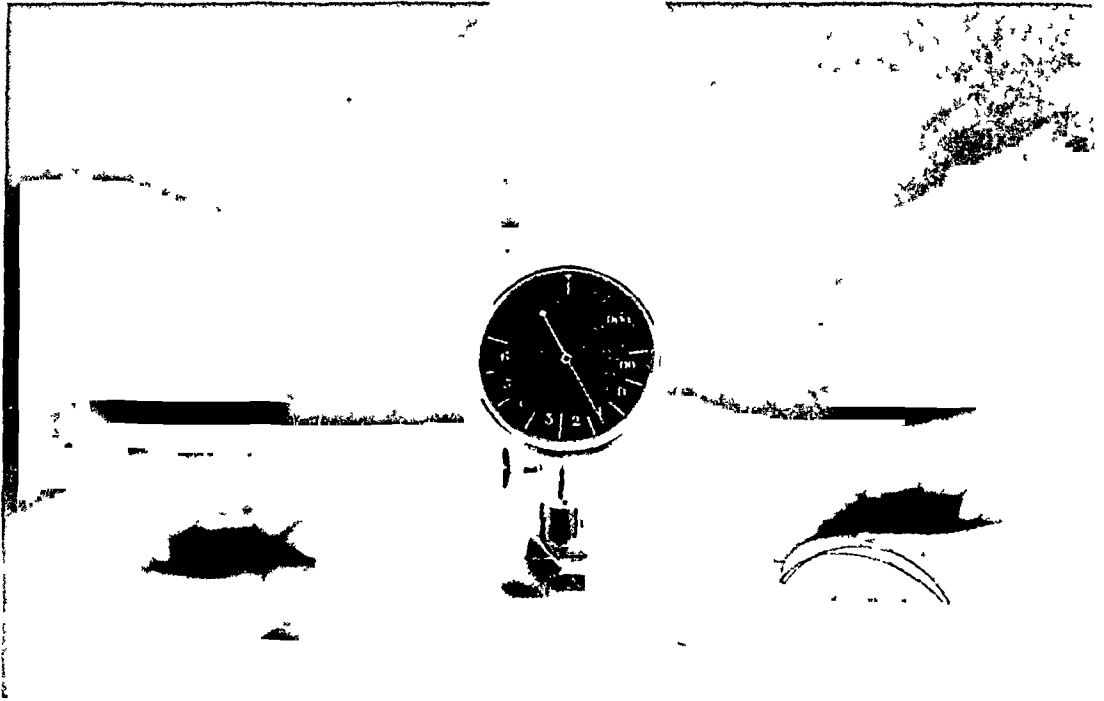
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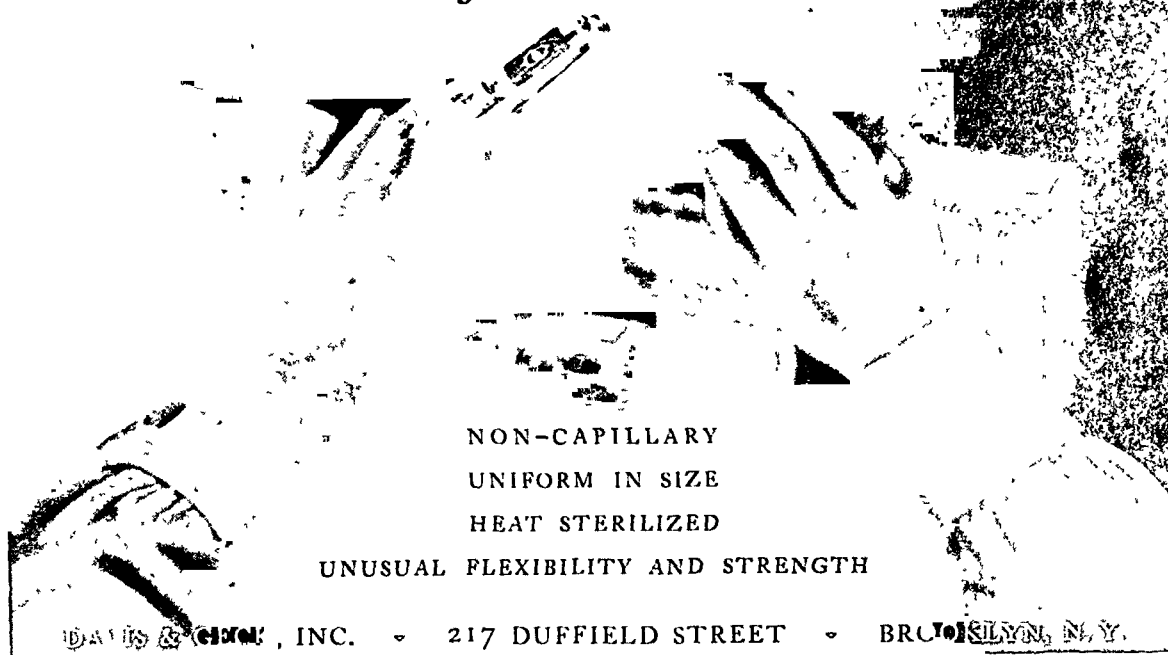


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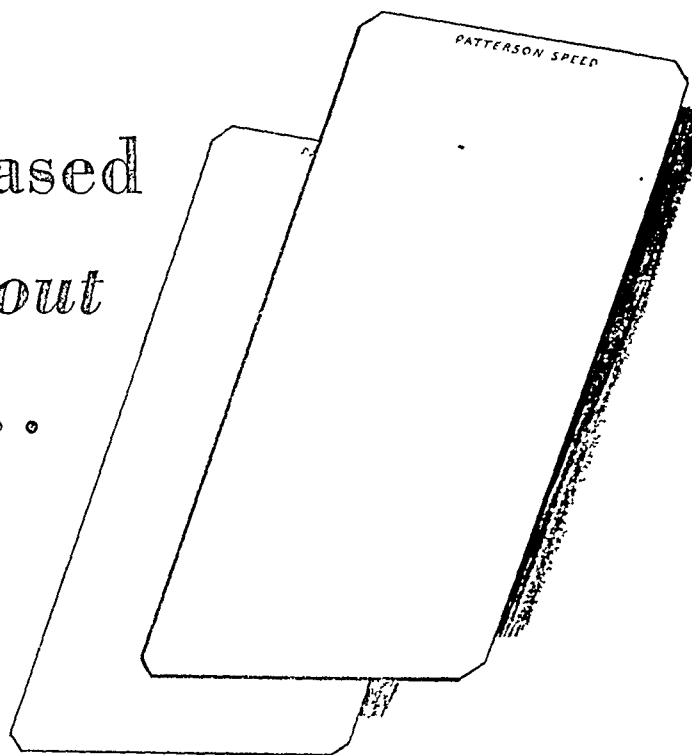
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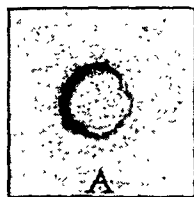
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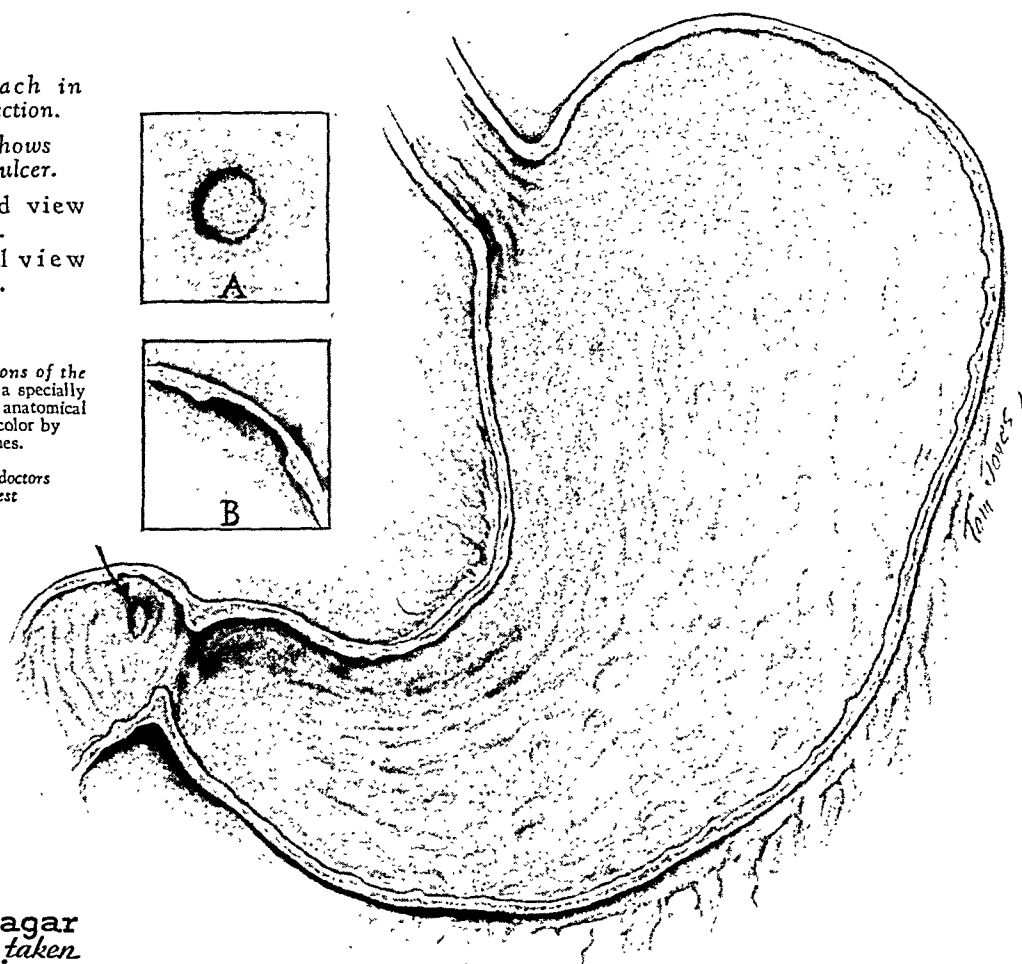
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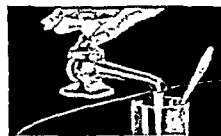
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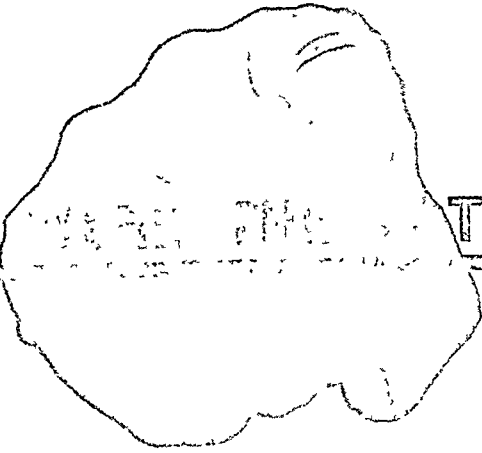
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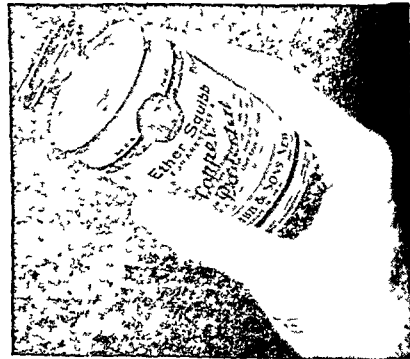
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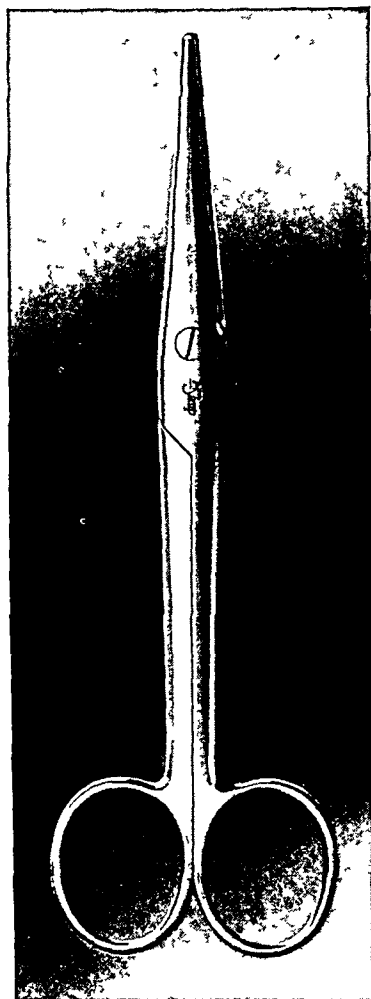
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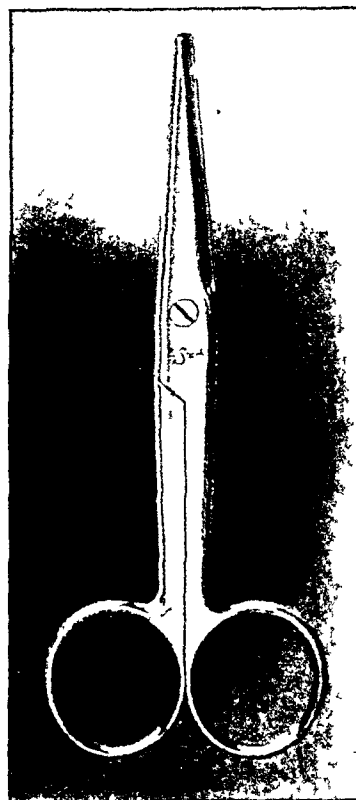
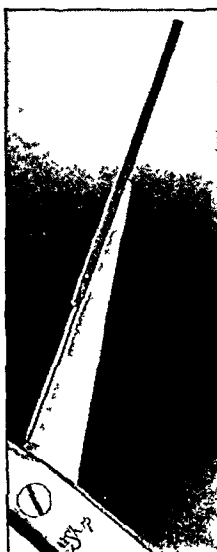
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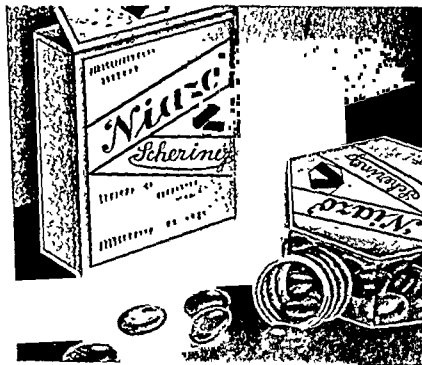
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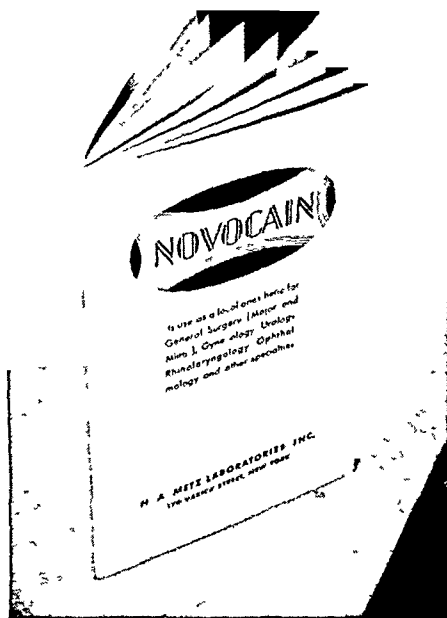
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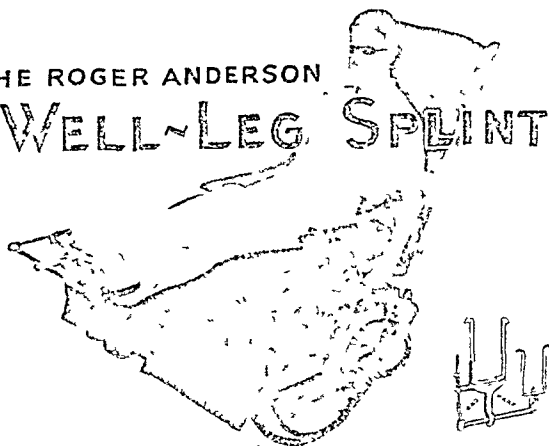
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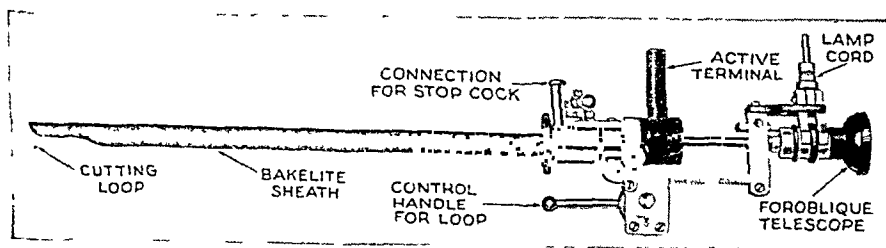
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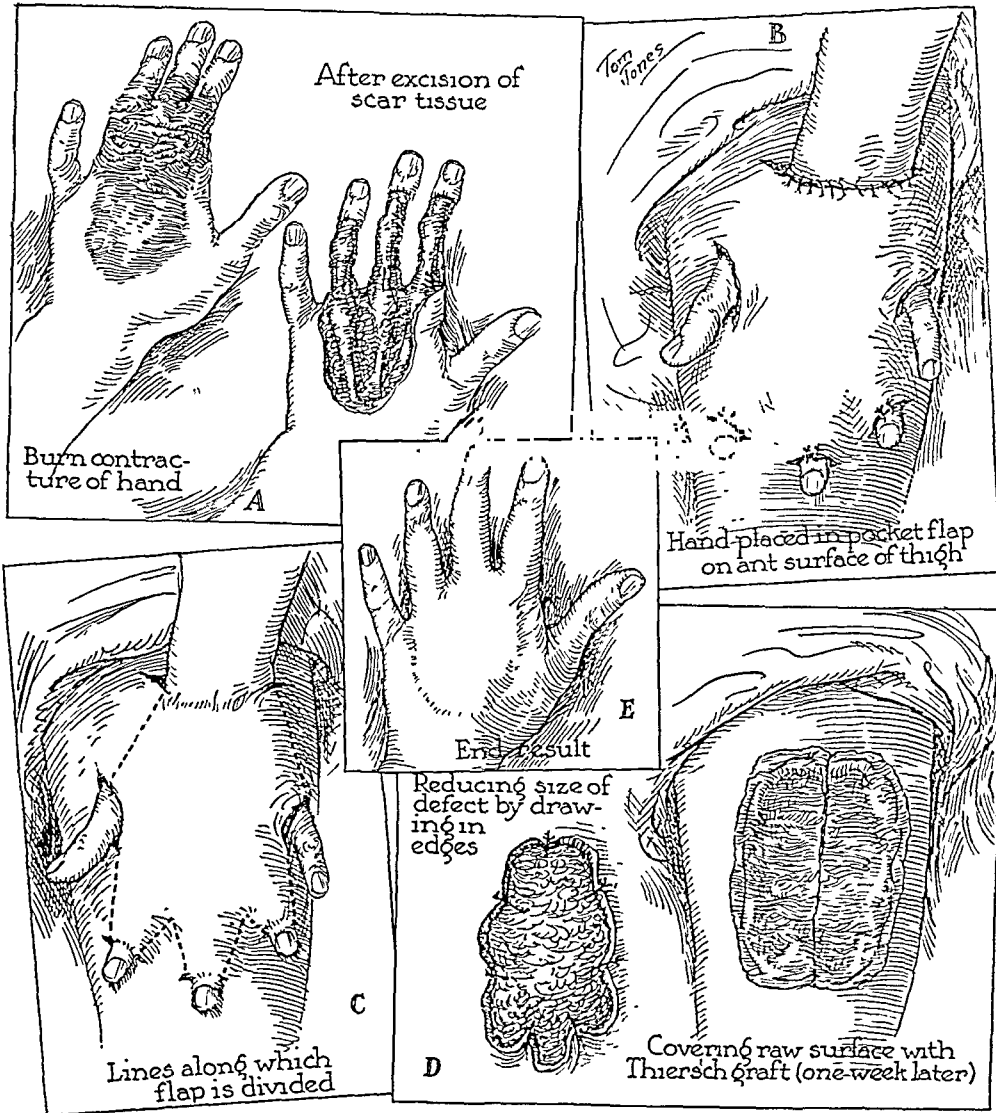
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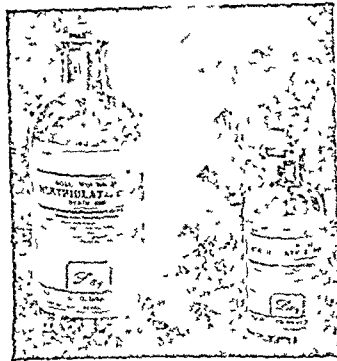
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NEW SERIES, VOL. XVII

AUGUST, 1932

No. 2

EFFECT OF IRRADIATION OF THE THYMUS ON ARTIFICIAL FRACTURES IN WHITE RATS*

M. W. METTENLEITER, M.D.

NEW YORK CITY

THERE is a vast amount of literature dealing with the function of the thymus gland. As in all endocrine glands it is difficult to attribute experimental findings exclusively to the thymus. The relationship in the endocrine system is too close. Still we are entitled to say that removal of the thymus produces certain changes. There is no full accord in experimental findings obtained by the removal of the thymus; but there has been full agreement reached on the influence of the thymus on bones. Removal of the thymus produces in young animals retardation of growth and softening of bones. Morphologically there is some similarity with rickets, osteoporosis and osteomalacia (Basch, Klose and Cozzolino). It has been found that bones in animals deprived of thymus contain less calcium than those with thymus. The fact that extirpation of the thymus causes disturbances in the ossification and the natural diminution of the gland after the period of growth seems to be significant of the relation of this gland with the osseous system. It was therefore rather logical that Basch and Sommer made experiments on fractures after removal of the thymus. Their findings were in accord with the hitherto known bad callus formation and slow healing process.

A new experimental method was employed by Milani who destroyed the function of the thymus by means of very high doses of x-rays. The growth of the animals ceased and they died, as after the operative removal of the gland. Now it will be interesting to note the results of implantation of the thymus gland. Dehmel states the following findings in rats: Young animals are more lively and better developed in spite of increased obesity. The growth of bones is especially stimulated by implantation of glands from young animals. There is no difference in the strength of the bones. There is no apparent influence on other glands. Feeding of thymus substance showed no influence at all. This is in accordance with experiments of Sinnhuber whose results gave no evidence of any change in the calcium metabolism. The implantation method is not commonly used on human beings. Lesser and other investigators expressed some doubts about the value of this method.

On the other hand, some practical application of these experiments could be expected, if stimulation of the activity of the thymus could be achieved as for instance by means of small x-ray doses. In 1905 Heinecke discovered the hypersensitivity of the thymus gland to x-rays.

* Submitted for publication November 2, 1931.

He radiated the thymus of cats and after three and one half hours observed characteristic changes in the lymphoid tissues of

artificial bone fractures. As the most significant changes take place apparently in the bones, the healing of fractures repre-

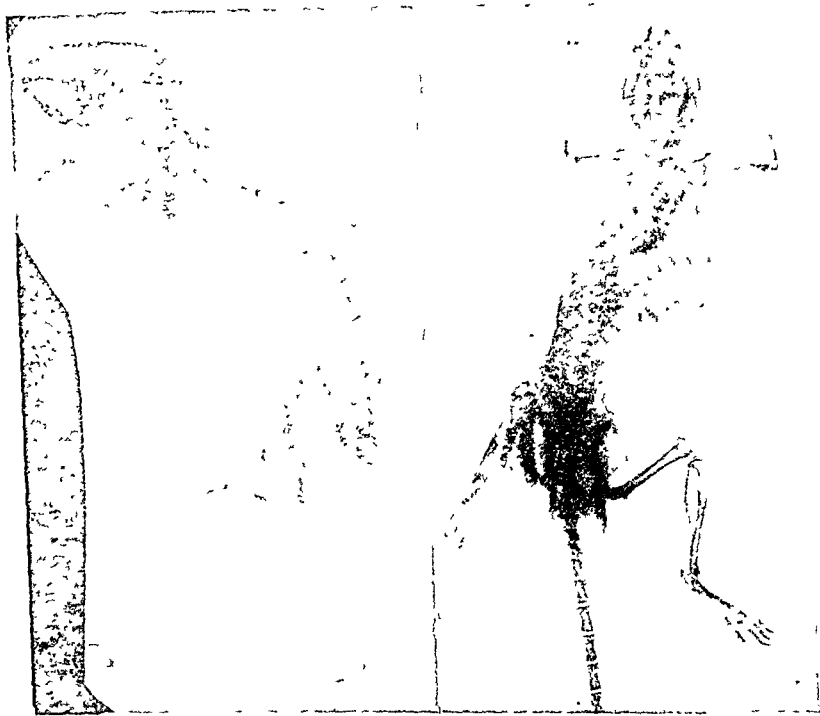


FIG. 1A.

FIG. 1B.

FIG. 1. Experiment II.

A. Radiated animal. Fractured Sept. 17, 1930. Radiated, 10 per cent, Sept. 17, 1930. X-ray taken Oct. 21, 1930.
B. Control. Fractured Sept. 17, 1930. X-ray taken Oct. 21, 1930.

the thymus gland (destruction of nuclei, phagocytosis of chromatin particles). Rudberg confirmed and carried out in detail these findings. The clinical result was radiation of the thymus in cases of hyperplasia, a method which gave very good results. Its aim is functional reduction of the activity of the gland.

Experiments concerning the stimulation of the thymus were carried out by Lenz. He radiated the thymus of young rabbits with small doses of x-rays and studied the microscopical changes in the thymus and spleen at different intervals after the radiation. Lenz came to the conclusion that a hypofunctionating thymus cannot be stimulated by exposing it to roentgen rays in a fraction of an erythema dose. But there are no experiments concerning the influence of thymus irradiation on

sents the best test for any effect of the radiation. The experimental plan was therefore based upon radiation of the thymus with small doses after a fracture was set.

The application of small doses on endocrine glands is not new. It represents a valuable method in the treatment of amenorrhea. Radiation of the ovaries with the so-called "stimulation dose" gives good results in some cases, especially in secondary amenorrhea. No theoretical discussion about the stimulation dose is intended here. The rule of Arndt-Schultze is presumably applied for rays as it is for other biological processes.

In our experiments we used rats aged from three weeks to one year. One group was kept on standard diet consisting of milk, vegetables and bread. Another group

was kept on Steenbock diet for two weeks prior to the experiment. This was done to find out if the effect of radiation has any bearing on a low calcium content. The animals were of the same weight and taken from the same litter. To each group the same number of control animals were added. If the litter was sufficiently large the animals were divided into both groups. The femur was fractured under general anesthesia and an x-ray picture taken to verify the fracture. On the same day or twenty-four hours later radiation was applied to the thymus. We used hard filtered radiation: 200 kv., 4 ma., 0.8 Cu + 1 Al, 40 cm. distance. Great care was taken that the animals were completely immobilized during the radiation. The body was protected by means of rubber-lead and only an area of 1.5 cm. was left open as port of entry for the radiation. By this method the unnecessary space radiation was avoided and the best condition for an exclusive radiation of the thymus was given.

The question may arise whether the parathyroid glands were also affected by the radiation. If they were the effect was supposed to be similar to that on the thymus. Removal of the parathyroid glands would not have been the proper way to exclude the possible effect of the radiation. Their removal produces such great changes in the calcium metabolism and the nervous system, that no valuable observation would have been possible. Furthermore we know the results of the removal of the gland and could easily judge our findings from them.

In detail the results obtained are shown by Table 1.

The results of these experiments show in all cases a clear difference between the radiated and control animals. Callus formation set in one to two weeks later in the control animals. The complete healing which was judged by a satisfactory callus formation on the x-ray plate and the clinical examination, showed an average of three weeks in the radiated animals against four weeks in the control. It is

impossible to define the beginning of callus formation exactly to the day. The animals had to be anesthetized whenever a picture



FIG. 2A.

FIG. 2B.

FIG. 2. Experiment III.

- A. Radiated animal. Fractured Oct. 13, 1930. Radiated, 10 per cent, Oct. 13, 1930. X-ray taken Nov. 5, 1930.
- B. Control. Fractured Oct. 13, 1930. X-ray taken Nov. 5, 1930.

was taken and a possible damage from the frequent anesthetics had to be avoided. All other conditions being equal the radiation of the thymus must be held responsible for the quicker repair of the fractures.

It is rather surprising that the old animals responded as well as the young animals. That this is not a mere coincidence is proved by the reaction of the animals of different ages in the two groups. The healing of the fractures in young animals requires the same time as in the oldest ones. This is absolutely in accordance with anatomical and physiological studies which prove that the remaining thymus tissue after the normal involution keeps its function up to old age. Waldeyer found thymus tissue in men aged from sixty to eighty. Svehla observed that the application of

TABLE I
(Regular Stock Diet)

Group	No. of Animal	Age	Date of Fracture	Date of Radiation	Dosage	Callus Formation after:			
						2 Weeks	3 Weeks	4 Weeks	5 Weeks
	512	3 weeks	9-9-30	9-9-30	10 per cent Sk. E. D.	+	+++		
	513		do.	do.		+	+++		
	514		do.	do.		+	+++		
	515		do.	do.	do.	+	+++		
	516	do.		Control	Control	-	+	+++	
	517		do.	do.	do.	-	+	+++	
	518		do.	do.	do.	-	+	+++	
	519				do.	-	+	+++	
II	524	4 months	10-13-30	10-13-30	10 per cent Sk. E. D.	++	+++		
	525		do.	do.		++	+++		
	526		do.	do.	25 per cent Sk. E. D.	++	+++		
	527		do.	do.		++	+++		
	528	do.		Control	Control	+	++	.....	+++
	529		do.	do.	do.	+	++	.....	+++
	530		do.	do.	do.	+	++	.....	+++
	531					+	++	.....	+++
III	520	6 months	10-9-30	10-9-30	10 per cent Sk. E. D.	+	+++		
	521			do.		+	+++		
	522			Control	Control	-	+	+++	
	523		do.	do.	do.	-	+	+++	
IV	532	5 months	10-29-30	10-30-30	10 per cent Sk. E. D.	++	+++		
	539		do.	do.		++	+++		
	537		do.	do.	50 per cent	-	++	.....	+++
	538					-	++	.....	+++
	533	do.	do.	do.	75 per cent	-	++	.....	+++
	534					-	++	.....	+++
	535					-	++	.....	+++
	536		do.	do.	100 per cent	-	++	.....	+++
	540	do.	do.	do.	Control	-	++	.....	+++
	541		do.	do.	do.	-	++	+++	+++

TABLE II
(Steenbock Diet #2966)

Group	No. of Animal	Age	Diet	Date of Fracture	Date of Radiation	Dosage	Callous Formation after:		
							3 Weeks	4 Weeks	5 Weeks
V	501	9 weeks	Steenbock #2966	9-17-30	9-17-30	10 per cent Sk. E. D.	+	++	+++
	502						+	++	+++
	504						+	++	+++
	505						-	+	++
	506	do.	do.	do.	Control	Control	-	+	++
	507						-	+	++
							-	+	++
							-	+	++

thymus extract gives better results with increasing years. Stoeltzner also demonstrated that the thymus gland remains active during the life. Dehmel found that implantation of thymus of eight months

old rats still has a stimulating effect on young animals.
The results of our experiments prove that x-ray radiation with small doses is stimulating for thymus substance in fully devel-



FIG. 3A.



FIG. 3B.

FIG. 3. Experiment IV.

- A. Radiated animal. Fractured Oct. 9, 1930. Radiated, 10 per cent, Oct. 9, 1930. X-ray taken Oct. 27, 1930.
 B. Control. Fractured Oct. 9, 1930. X-ray taken Oct. 27, 1930.



FIG. 4A.



FIG. 4B.

FIG. 4. Experiment V.

- A. Radiated animal. Fractured Oct. 29, 1930. Radiated, 10 per cent, Oct. 30, 1930. X-ray taken Nov. 12, 1930.
 B. Control. Fractured Oct. 29, 1930. X-ray taken Nov. 12, 1930.

oped animals. The experiments with the high dosage confirm Milani's findings and show that 25 per cent is the limit for the

It is quite evident that x-ray radiation in small doses may be applied in cases of delayed healing of fractures, which are



FIG. 5A

FIG. 5B.

FIG. 5. Experiment v.

- A Radiated animal. Fractured Oct. 29, 1930. Radiated, 50 per cent, Oct. 30, 1930. X-ray taken Nov. 12, 1930.
 B Control Fractured Oct. 29, 1930. X-ray taken Nov. 12, 1930.

stimulating dose. A higher dose is destructive. Quicker healing is apparently produced by an increased calcium supply to the fractured bone. The animals which were deprived of calcium by the Steenbock diet required a more prolonged time for healing. And still the influence of radiation is apparent. This reaction very likely consists in an augmented faculty of the bones to store up calcium. This confirms the observation that animals deprived of their thymus glands are not as well able to store calcium in their bones.

Our experiments therefore show that the functional stimulation of the thymus increases the affinity of the bones for calcium and favors the healing of fractures. The x-ray pictures illustrate the experiments in their various stages.

mostly caused by a disturbance in the intermediary metabolism.

CONCLUSIONS

1. X-ray doses of 10-25 per cent have a stimulating effect on the thymus gland of young and old rats.
2. Artificial fractures show a quicker repair after radiation of the thymus than those of control animals.
3. The hyperactivity of the gland results in an increased affinity of the bones to calcium.
4. Small x-ray doses may be applied to the thymus in cases of delayed healing of fractures in human beings.

[For References see p. 205].

RETROPERITONEAL APPROACH IN SUBPHRENIC ABSCESS*

CHARLES W. FLYNN, B.S., M.D., F.A.C.S.

DALLAS, TEXAS

WHEN the operative mortality rate for any surgical disease remains consistently high, suspicion points toward some inadequacy in the procedures employed. Subphrenic abscesses have long been outstanding among this group of diseases. Various reports have shown mortalities of from 32 per cent to 66 per cent in operated cases. In most of these cases the transpleural or transperitoneal routes of approach were used in draining the abscesses and death was often due to rapidly following empyema or general peritonitis. Then in 1923 Nather and Ochsner described a technique for extraperitoneal drainage of the subphrenic spaces, designed to avoid contamination of the major serous cavities. It is the purpose of this paper to present some personal experiences with this method, together with a report of recent results obtained by other members of the Southern Surgical Association. These results show beyond a doubt that the Nather-Ochsner operation has been a most valuable contribution to the science of surgery and that the use of this operation, wherever possible, will materially diminish the number of fatalities due to subphrenic abscess.

Recent articles by Ochsner, McNamee, Elkin and others have given detailed consideration to the anatomical, pathological and clinical aspects of the disease under discussion. However, a brief review of some of these points will tend to emphasize the principles involved in the extraperitoneal operation.

In the first place, the anatomical relationships of the structures underlying the diaphragm are of prime importance. The subphrenic region is best considered from a surgical standpoint to include that portion

of the abdominal cavity between the diaphragm above and the transverse colon below. This is primarily divided by the liver into suprahepatic and infrahepatic areas. The suprahepatic area is secondarily divided into four spaces by the reflections of the peritoneum from the under surface of the diaphragm on to the superior surface of the liver known as the falciform and coronary ligaments. To the left of the falciform ligament the backward course of the left prolongation of the coronary leaves a single space on that side. To the right of the falciform ligament there are three spaces produced by the separated leaves of the right prolongation of the coronary ligament. These are a small posterior space behind the posterior leaf, a large anterior space in front of the anterior leaf, and a retroperitoneal space between the leaves. This small posterior space and the retroperitoneal space are of the greatest clinical importance. In a series of 78 cases of subphrenic abscess Fifield and Love reported 31.7 per cent occurring in the right posterior space and 25.6 per cent in the retroperitoneal, 57.3 per cent in the two spaces.

The infrahepatic area is divided by the round ligament and the ligament of the ductus venosus into right and left spaces. The left inferior space is further divided into anterior and posterior spaces by the lesser omentum. The left posterior space is the lesser peritoneal cavity. Abscesses of the infrahepatic spaces occur less frequently than those above the liver, and often in combination with them.

Infection localizing in the subphrenic region does not always proceed to the point of suppuration and abscess formation. Probably more than half of such

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infections heal spontaneously and often their existence may never be suspected. Old inflammatory adhesions between the

extension of the organisms or through the retroperitoneal lymphatics.

Infecting organisms may be carried by

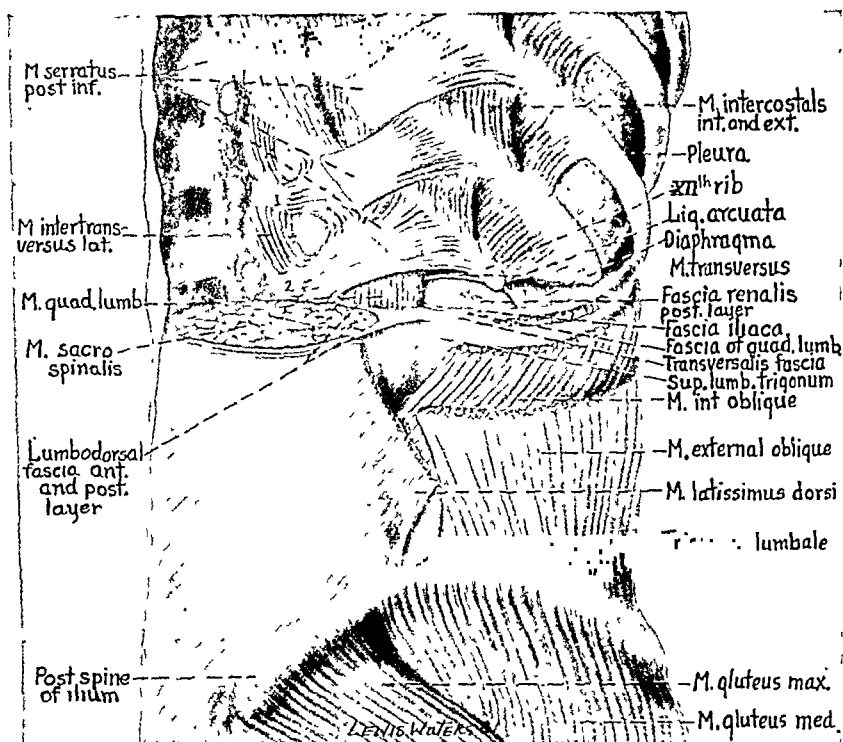


FIG. 1. Dissection showing relations of muscles of lumbar region to approach for retroperitoneal operation for subphrenic abscess. Slightly from right side. (From Dept. of Med. Art, Baylor Univ. Med. School.)

diaphragm and the superior surface of the liver or in the infrahepatic region are frequently encountered during abdominal explorations or at autopsy. These are definite evidences of healed subphrenic infections.

The source of infection is in the main some suppurative process within the abdominal cavity. Acute perforated appendicitis is most often to blame. Subphrenic abscess formation can also follow simple acute unperforated appendicitis. Perforated gastric or duodenal ulcers follow appendicitis closely, and infections of the gallbladder and bile ducts are next in order of frequency. Hydatid cysts, pancreatitis, splenitis, renal infections and other intra-abdominal conditions may be causative factors. The path of infection from all these lesions is either by direct

the blood stream from lesions outside the peritoneal cavity. Such sources are carbuncles, osteomyelitis, respiratory infections, and others.

Of 346 cases brought to my attention through personal communications with 105 members of the Southern Surgical Association, the sources of infection were as follows:

	Cases	Percentage
APPENDICITIS.....	187	54.0
RUPTURED VISCUS..... (Stomach, Duodenum, Gall Bladder)	81	23.4
MISCELLANEOUS..... (Acute pancreatitis, Renal infection, Liver abscess, Resection of intestinal malignancy, Splenectomy)	59	17.1
EXTRA-ABDOMINAL LESIONS..... (Influenza, Lung abscess, Empyema, Septic abortion, Acute salpingitis, Cesarean section, Osteomyelitis, Furunculosis)	19	5.4

Early diagnosis of subphrenic infection is extremely difficult. Even a large accumulation of pus in this region may escape

disease and its appearance in the x-ray cannot be waited for.

When the presence of subphrenic infec-

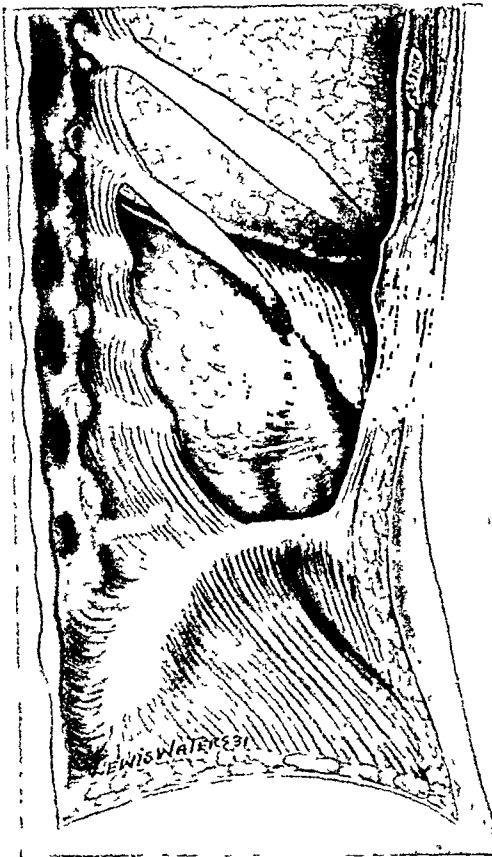


FIG. 2. Dissection showing muscles removed to expose expanded lung, diaphragm and renal fascia. Portion of diaphragm has also been removed, revealing margin of liver and ascending colon through renal fascia and peritoneum. (From Anat. Dept. & Dept. of Med. Art, Baylor Univ. Med. School.)

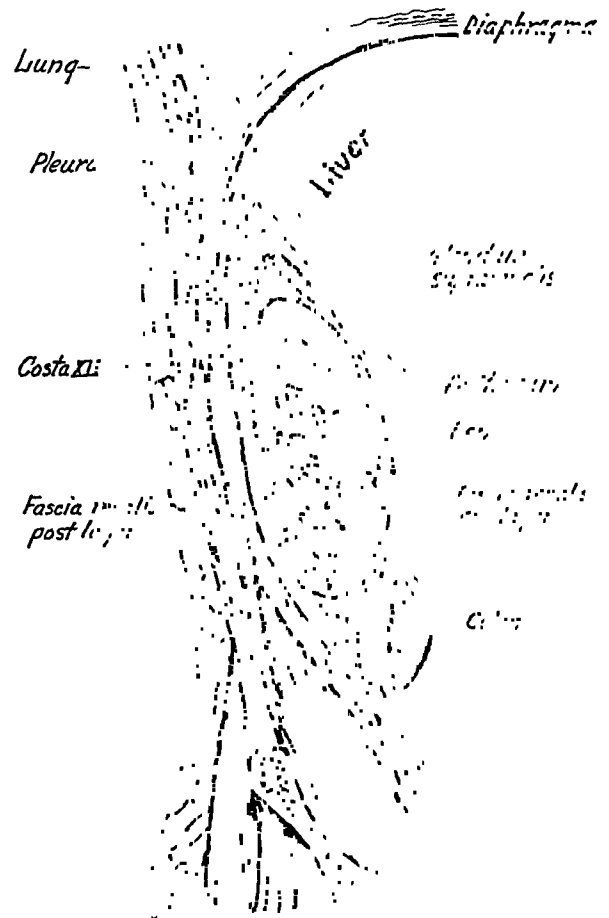


FIG. 3. Sagittal section showing relation of diaphragm to anterior and posterior layers of renal fascia and to peritoneum. (From Dept. of Med. Art, Baylor Univ. Med. School.)

detection because the symptoms are often vague and the signs misleading. The condition should be suspected in any patient who has been recently treated for a suppurative lesion within the abdomen and in whom signs of infection persist or return even after a period of several months. This suspicion is strengthened by the appearance of soreness and localized tenderness in the right flank, along the right twelfth rib, or even along the right costal margin. X-ray findings are of utmost importance as confirmatory evidence. Fixation and elevation of the diaphragm on the right are the significant features. A gas bubble under the diaphragm develops only late in the

tion is suspected, conservative medical treatment with supportive measures and local application of heat may cause the process to subside. If such measures are unsuccessful, and it seems certain that an abscess has formed, incision and drainage must not be delayed. Risk of contaminating the pleural or peritoneal cavity makes exploratory aspiration an unwise procedure.

Some form of extraperitoneal approach to the abscess cavity is, I believe, the method of choice. With the exception of those few cases where the localization is obviously anterior, the Nather-Ochsner operation offers a safe and rational plan of procedure. One advantage of primary

importance is that it can be easily done under local or a combination of local and gas anesthesia.

If no pus is obtained by aspiration, the dissection of the peritoneum from the diaphragm is continued until the supra-



FIG. 4. Bed of twelfth rib after incision has been made and rib resected subperiosteally. Dotted line shows location of deep transverse incision at level of first lumbar spinous process which is to extend down to renal fascia. (From Anat. Dept. & Dept. of Med. Art, Baylor Univ. Med. School.)

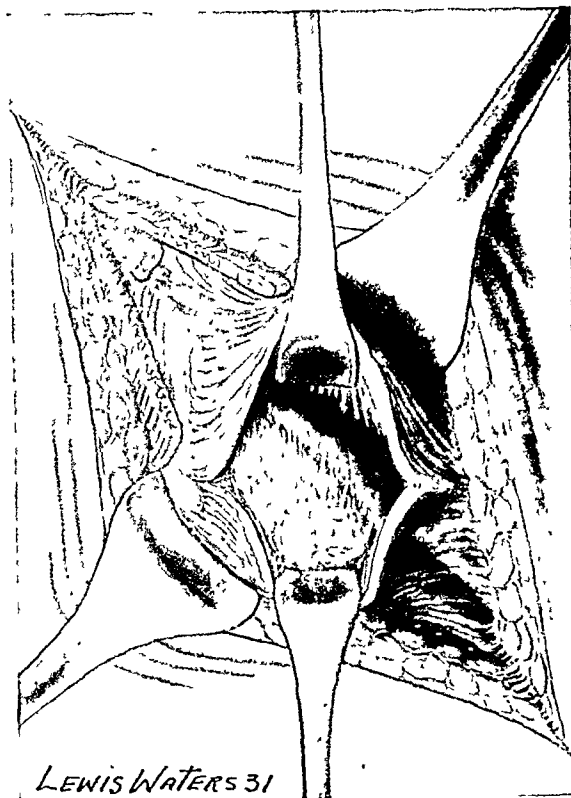


FIG. 5. Exposure of under surface of diaphragm and beginning of its separation from peritoneum. (From Anat. Dept. & Dept. of Med. Art, Baylor Univ. Med. School.)

With the patient on the left side, an incision is made over the twelfth rib and the rib resected subperiosteally. The most important step of the operation follows, which is a "transverse incision through the attachment of the diaphragm below the bed of the resected twelfth rib at the level of the first lumbar spinous process." At the bottom of this incision the renal fascia is readily identified by the appearance of the renal fat beneath, and the posterior parietal peritoneum, which is continuous with the renal fascia, is dissected with the finger from the under surface of the diaphragm. Before this dissection has proceeded too far, it is a safe plan at this point to explore the right infrahepatic space with a needle.

hepatic abscess is entered, the pus evacuated, and rubber tube drains placed. In case pus is obtained by aspiration in the infrahepatic region, no incision is made until the exploration of the suprahepatic region is completed. If indicated, the pleural cavity can also be explored with an aspirating needle as the costophrenic angle is readily accessible from beneath. If empyema is found it may be drained through the same incision.

Subphrenic abscesses located anteriorly may be also drained extraperitoneally by the use of Clairmont's operation. An incision is made along the costal margin down to the peritoneum, which is then separated from the anterior abdominal wall and the under surface of the diaphragm until the abscess is reached.

I should like to present in some detail 2 cases recently encountered and successfully treated by the Nather-Ochsner operation:

CASE I. Z.E.A., aged twenty-one, carpenter, entered the hospital January 31, 1931, complaining of severe pain in the epigastrium, of twelve hours' duration. The abdominal wall was rigid and a diagnosis of perforated gastric ulcer was made. Operation was performed immediately, a perforated gastric ulcer was resected and the defect in the stomach was closed. Convalescence was stormy. On the third post-operative day, pneumonia developed. On the eleventh day when the pneumonia was clearing satisfactorily, signs of acute intestinal obstruction appeared. The incision was re-opened, a band of constricting adhesions divided and a jejunostomy done. The patient began to recuperate rapidly but on about the seventeenth day he complained of pain in the right lumbar region. This pain, together with a slight temperature elevation, persisted. The wound healed and he was allowed to leave the hospital but was kept under close observation. Six and a half weeks after the first operation he was re-admitted with increased pain in the right flank and temperature ranging from 99° to 103°F. X-ray pictures showed a shadow at the right lung base suggesting empyema but aspiration of the pleural cavity yielded only a few cubic centimeters of serous fluid. This tended to confirm the suspicion that a subphrenic abscess was present. Nine weeks after the first abdominal operation, the extraperitoneal operation of Nather and Ochsner was done and about 300 c.c. of pus drained from the posterosuperior subphrenic space. Drainage tubes were placed and recovery was rapid. The patient left the hospital three weeks after the last operation. The wound was completely healed in two months and he returned to work.

CASE II. J.T.H., aged seventy-nine, lumberman, entered the hospital March 8, 1930, complaining of severe pain in the right inguinal region where he had had a large hernia for many years. Eight days before, he had injured the hernial region by falling over a chair and the pain had been increasing in severity since that time. Two days before admission he began vomiting and was found to have a temperature of 102°F. Nausea, vomiting and fever continued, marked tenderness and muscular rigidity in the right lower adominal quadrant were

found and operation was advised. Incision was made above the inguinal canal and a large appendiceal abscess was drained through the hernial sac. After a severe respiratory infection and phlebitis of the right leg, he improved sufficiently to be discharged from the hospital twenty days after the operation. After another four weeks the wound had completely healed. He remained in excellent health except for one severe attack of cold and bronchitis with fever lasting two weeks, until sixteen months after his operation, then he began to complain of pain in the right kidney region and ran a daily temperature elevation of 101°F. He was again admitted to the hospital where the diagnosis of subphrenic abscess was made, based on the pain and tenderness in the right flank and x-ray evidence of a fixed and elevated right diaphragm. On July 21, 1931 the abscess was drained extraperitoneally. His recovery was rapid and uneventful, and he is still quite well.

I operated on a third case several years ago, using the transperitoneal approach. This patient died of peritonitis.

One hundred and five surgeons answered my questionnaire concerning their experiences with subphrenic abscesses. Forty-four had no cases to report. Most of these men are engaged in special branches of surgery which do not involve the treatment of abdominal disease. The remaining sixty-one reported a total of 346 cases, of which 333 were operated upon. Three hundred and thirteen of these operations could be grouped definitely under one of three types, i.e., transpleural, transperitoneal or extraperitoneal. In this group there were 87 deaths, or a general mortality rate of 37.9 per cent. Transpleural or transperitoneal operations were used in 275 cases with a mortality of 41.0 per cent.

	Cases	Deaths	Percentage
TRANSPLEURAL, TRANSPERITONEAL AND EXTRAPERITONEAL OPERATIONS.....	313	87	37.9
TRANSPLEURAL OR TRANSPERITONEAL.....	275	80	41.0
EXTRAPERITONEAL.....	38	7	18.4

The extraperitoneal operation was used in only 38 of the 313 cases. Out of this 38

there were seven deaths, a mortality of 18.4 per cent. This last series is too small to allow any definite conclusions to be drawn. A comparison of the 18.4 per cent mortality with the 41 per cent however is a striking one, and even more striking is the result obtained in the series which Ochsner himself has treated. In this series, 19 patients with subphrenic abscess were operated upon through the extraperitoneal approach and only one death followed, a mortality of 5.2 per cent. As the sound principles involved in the technique of the extraperitoneal approach are more widely recognized, and it becomes more generally employed, I am confident that other

series with results equally gratifying will be reported.

SUMMARY

1. Subphrenic abscess is briefly considered from the standpoint of anatomical relationships, pathology, diagnosis and treatment, especially by operation through the extraperitoneal route.

2. The etiology is given in a group of 346 cases treated by sixty-one surgeons.

3. Two cases treated successfully by the extraperitoneal operation are reported.

4. The mortality rates are given for a group of 313 cases treated by transpleural, transperitoneal and extraperitoneal operations.

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GONORRHEAL INFECTION OF THE KIDNEY PELVIS

REPORT OF FOUR CASES*

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GONORRHEAL infection of the kidney is rare.¹ It is not so extremely uncommon for a severe gonorrhea to be accompanied by a pyelonephritis, but this is seldom due to gonococci.² However, Barney,³ in reporting his case which resulted in nephrectomy, stresses the point that undoubtedly many cases pass unnoticed because of very mild symptoms with recovery under palliative treatment.

In most case reports the diagnosis of gonorrheal kidney infection is based upon the finding of gonococci in the urine with an accompanying pyelitis. Birkhaug and Parlow⁴ contend that only those cases can be considered authentic which show positive fermentation and serological reactions and they find record of only 4 cases that meet this requirement. Obviously this is impracticable as a clinical routine. Finding gram-negative intracellular diplococci—morphologically gonococci—in urine obtained by ureteral catheterization in a patient with an uncured gonorrhea is evidence of gonorrheal pyelitis. This may further be checked by culture on Löffler's serum agar. If the diplococcus grows on this medium it is not gonococcus. In line with this thought Thomson⁵ of London feels that diagnosis of a gonorrheal kidney infection is entirely microscopical, and Sakata⁶ contends that demonstration of gonococci by either staining or cultural methods from material obtained from the kidney pelvis or the kidney parenchyma is proof of gonorrheal kidney infection. He finds only 24 definitely proved cases and discards a large number based upon subjective evidence.

Four theories have been advanced to explain possible routes of infection of the

upper urinary tract: (1) Albarran and others^{7,8} contend that the hematogenous route is the most common. (2) Luys,⁹ in his textbook on gonorrhea, leans toward the ascending route, contending that the ureteric orifices in gonorrheal trigonitis are enlarged and gape, and the urine easily flows backward from the infected bladder and finds its way to the kidney. However, when there is no concomitant cystitis, he feels that it may pass through the blood stream. (3) The lymphatic system, as the third possible route, was *apparently* experimentally demonstrated by Sakata¹⁰ as remotely possible. Stanton¹¹ reports a case which he believes tends to show that it is possible to infect the kidney from the bladder through the lymphatics. The weight of evidence does not support the contention of frequent extension along this route. (4) Lack of sufficient proof at once discards contiguity as the fourth route.

Consideration of the ascending route naturally involves some hindrance to normal drainage in the lower urinary tract, with back pressure, poorly functioning ureteral sphincters and ascending infection.

Hazy or cloudy urine (glass 2 of a two-glass test) may be the only subjective symptom of gonorrheal pyelitis. An occasional dragging weight or very slight tenderness in the kidney region may be present. Symptoms intermediate from this to severe pain in the loins, temperature ranging as high as 103° or 104°F. with definite chills or chilly feeling, may accompany gonorrheal bacteremia or extensive kidney involvement. Irreparable damage to the kidney and even nephrectomy has been the terminal result of some of these cases. Simmons¹² describes his patient as

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having no symptom referable to the kidney until an injury brought him in for operation. J. K. Way,¹³ a few days after examination and hospitalization of his patient for acute gonorrhea, opened a renal abscess due to extension of this process to the kidney. After a period of six years' quiescence in Lehr's¹⁴ case, there was cloudy urine and terminal hematuria. On study the cause was found to be that of gonorrheal pyelitis.

Three of the cases presented below are mixed infections and in the fourth only the gonococcus was found. The question whether gonorrheal infection of the kidney is primary or superimposed upon a previous infection with the ordinary pyogenic organisms is of more than academic importance. Enough cases of pure gonorrheal infections of the kidney have been reported to establish definitely that gonococci may attack a previously uninfected kidney, but there is no proof that such kidneys were not more susceptible for reasons of increased intrapelvic pressure, due to slight mechanical hindrance to drainage of one kind or another, or other damage to the kidney by back pressure, sometimes unilateral. The basic treatment, however, is the same in either instance: relief of stasis and obstruction or other hindrance to drainage. Of secondary consideration is the use of bactericidal substances.

CASE I. V. I. M., male, thirty-seven years of age, married eight years, wife never pregnant, occupation: truck driver.

August 11, 1930 he came to the office complaining of pain in the left testicle. For the past ten years he has had periodic attacks of dull grabbing pain in the loins, lasting a few days. No attention was paid to it. A haziness of the urine was also noticed for which he received treatment. In 1921 he had an acute epididymitis on the left side. He was unaware of an urethral discharge preceding it and the cause was unknown to him. It apparently cleared up completely in two weeks. He was at no time bedridden.

July, 1928 he contracted his first and only attack of gonorrhea. The gross discharge

disappeared in six weeks; no complications. The pains in the kidney regions became more accentuated. In February, 1929, a double epididymitis developed which kept him in bed for five days. The right side cleared up in about a week. The left side, however, remained slightly painful and tender to date. The patient remarked that his urine has been cloudy since the initial infection and he now urinates every two hours during the day and three times during the night. He has no dysuria and has never had hematuria. He has no digestive or nervous complaint.

His previous history tells us that he had mumps in his boyhood without complication and influenza in 1918 without sequela. Family history is irrelevant.

The man is well nourished, mentally clear, shows no signs of acute illness or distress. Blood pressure is 120/84. Temperature and pulse are normal. Examination of the patient, exclusive of his urinary tract, is essentially negative.

Urinary System: There is no urethral discharge. The left globus major is perhaps a trifle enlarged, but distinctly not a tuberculous epididymitis. Urine is hazy, neutral, specific gravity 1.005; does not clear with acetic acid, is negative for sugar, faint trace of albumin, and there is a small thick sediment. Microscopic examination shows very many pus cells with an occasional R. B. C., many gram-negative intracellular and a few extracellular diplococci. Flat x-ray film is negative for calculus. There is no tenderness in the kidney regions.

Systematic treatment over a considerable period failed to bring about a cessation of pyuria. On February 25, 1931 a left vasectomy was performed. On March 17, 1931, because of persistence of symptoms, cysto-urethroscopic examination was done. The bladder mucosa and ureteral mouths were normal in appearance. Urinary drip was satisfactory. Pyelograms were taken.

Just what led to the suspicion of kidney infection and just what finally justified ureteral catheterization? The history of a man with a slight discharge only upon squeezing the urethra, pyuria with gonococci always present in both glasses of urine, with cloudiness in both always to about the same extent; with a prostate revealing no gross infection by palpation and the prostatic juice showing only a very small amount of pus upon micro-

scopic examination, no dysuria or evidence of active seminal vesical infection, no stricture and no relief nor any reaction from the passage of full sized sounds, necessitated locating the focus. Finally examination with a Stern cysto-urethroscope revealed a few hypertrophic lesions in the posterior urethra adjacent to the bladder neck. This, however, was not sufficient to account for the cloudiness of glass 2, its pus and the gonococci content. Accordingly, through a No. 21 McCarthy cystoscope, No. 4 ureteral catheters, occluded with pins, were inserted and gave us the urine containing gonococci. Later No. 7 catheters were used. The catheterized specimens give the following findings:

Left side: Sediment small. Few R. B. C., few pus cells, several groups of intracellular gram-negative diplococci (morphologically gonococci) and a moderate number of extracellular (grouped and scattered). Also very few gram-negative bacilli, grouped.

Right side: Small sediment, very occasional R. B. C., considerable number of pus cells, moderate number of intracellular gram-negative diplococci (morphologically gonococci) and many extracellular (grouped and scattered). Several groups of very small gram-negative bacilli.

Instillation of a 1:250 solution of silver nitrate was repeated four times. Pyelograms showed moderate hydronephrosis.

Diagnosis: Pyelitis of gonorrheal origin; hydronephrosis.

Patient is still under treatment.

CASE II. L. E. F., female, aged twenty-eight, single, occupation: stenographer.

Her complaint on October 14, 1925, was frequency and dysuria with a most severe pain one or two minutes after urination. She voids twice at night. This complaint began about seven months previously with terminal burning. Close questioning also elicits a history of a vaginal discharge, undoubtedly gonorrheal. She was treated by another physician with bladder irrigations of permanganate of potash and tampons which markedly lessened the discharge but only moderately did it improve the urinary symptom.

Physical examination reveals an urethral stricture which passes readily a No. 8 Hegar catheter. The catheterized bladder specimen of urine is cloudy, acid, heavy ring of albumin; microscopically there are many pus cells, an

occasional R. B. C., and considerable number of gram-negative bacilli.

Cystoscopic Examination: Bladder mucosa and ureteral mouths appear normal. No. 7 ureteral catheters were passed to both pelves. The urine from the left kidney was cloudy, weakly alkaline, moderate amount of sediment; microscopically there were a moderate number of pus cells, few R. B. C., and moderate number of gram-negative bacilli. That from the right kidney appears cloudy, reaction alkaline, small sediment; microscopically no pus, an occasional R. B. C., small deposit amorphous phosphates and no organisms.

Phenolphthalein: Right appeared in five minutes and 24 per cent was passed in twenty minutes. Left also appeared in five minutes, and the following twenty minutes gave 16 per cent. There was no bladder leakage. No change in findings up to July 9, 1926. The urine from the left kidney this time was clear, has a small sediment; microscopic examination showed a considerable number pus cells, few R. B. C., very few gram-negative bacilli and an occasional group of intracellular and extracellular gram-negative diplococci. On August 30, urethral smear showed many pus cells, and considerable number of intracellular and extracellular gram-negative diplococci. Under bladder and cervical treatment, the gonococci disappeared from urethra and for eight months no diplococci were found in either bladder urine or in smears taken from the urethra. June 26, 1928 the left kidney specimen showed numerous gram-negative diplococci. Treatment during this period consisted of ureteral dilatations and kidney lavages. Flat plate shows a calculus in the left kidney. August 7, 1929, a nephrolithotomy was done and the calculus extracted. Since then there has been a reappearance of gram-negative bacilli but once.

CASE III. Negro, male, aged thirty, admitted to the Los Angeles General Hospital September, 1918.

He complained of marked dysuria and frequency, pain and tenderness over right costo-vertebral angle. Afternoon temperature ranged between 103° and 104°F. Urine was cloudy and microscopically contained many pus cells and some R. B. C.

Cystoscopy was exceedingly distressing, so much so that the patient left the hospital immediately. Base of bladder on the right,

including trigone and right ureteral orifice, was intensely injected, edematous and inflamed. Right kidney specimen brought a thick purulent urine. This specimen disclosed a great number of gram-negative intracellular diplococci, morphologically gonococci.

CASE IV. W. T. E., male, aged fifty-two, single, occupation: elevator operator.

Patient was admitted to the Los Angeles General Hospital April, 1918, with a history of dull ache in the left costovertebral region, extending to the corresponding area of the abdomen. The early part of this month he experienced a sudden sharp pain in this region which continued for two or three days as a less acute ache. He had incontinence of urine and feces at this time. He noticed that the urine was cloudy but there was no hematuria, nor did he notice any calculus or gravel in it. In the previous March he had a similar attack which lasted two days.

He had gonorrhea first at twenty-two, which lasted six weeks and no complications developed. In 1910 he had it again, lasting two months. This was followed by generalized rheumatism for six months. In 1916 he had gonorrhea a third time, lasting one year, which was again accompanied by rheumatic pains all over the body. Since then his urine has been cloudy most of the time. He also has an uncomfortable tickling in the perineum.

Examination of the Urinary Tract: Urine is cloudy, heavy ring of albumin, no sugar; microscopically numerous intracellular gram-negative diplococci, and few gram-positive staphylococci. Cystoscopic examination: Bladder shows no pathology. The left kidney is non-functioning. Smear from the sediment of urine collected from this kidney discloses many gram-negative intracellular diplococci, morphologically gonococci; also gram-positive staphylococci. Radiographic study disclosed a large left infected hydronephrosis with a small calculus acting as a ball valve. Function of right side normal; no pus. Pyelogram normal. Nephro-ureterectomy was done May 1, 1918. The kidney, full of pus, burst on the table. Patient made satisfactory recovery and urine has remained clear to date.

SUMMARY

The finding of gram-negative intracellular diplococci, morphologically gonococci, in a specimen from the kidney pelvis

is the most important single factor in the diagnosis. Culture is too delicate a procedure to be expected routinely. Sometimes even formaldehyde or other agents used in sterilizing ureteral catheters may so affect the bacteria that no growth results. Contamination may overshadow and force the gonococci out of the picture. Culture of gonococci on Schwartz media from the urethral pus in an ordinary acute case of gonorrhea is often successful in the hands of the highest class of clinical laboratory worker, but one must be highly optimistic to expect a high percentage of positive cultures in cases of mixed infections. Case records in the literature fail to disclose any case of micrococcus catarrhalis infection that could well be mistaken for gonorrhea if the ordinary precautions and conscientious efforts, coupled with adequate experience in staining and examining smears of urethral pus, be exercised; while infection of the urinary tract by the meningococcus, unaccompanied by the clinical picture of meningitis, is such a remote possibility as to leave it out of consideration.

Of the cases presented, two underwent operative procedure, one nephrectomy and the other nephrolithotomy. One is still under treatment. Diagnosis was established microscopically previous to operation.

Considering the advanced cases which come to the urologist, it is not at all surprising that a goodly number of these kidney infections come to operation. Subjecting a patient with acute or subacute gonorrhea to ureteral catheterization is, generally speaking, contraindicated. However, in cases of long-standing gonorrhea with the second glass of urine of a two-glass test as cloudy as glass 1, containing a large amount of albumin, and after the lower genitourinary tract is considered excluded from the standpoint of sufficient pathology to account for these findings, especially when accompanied by a feeling of tightness, dragging sensation or pain in either costovertebral angle, one should be led to seriously consider ureteral catheterization.

For the purpose of this examination, only the smallest and most flexible catheter with a pin in the outer end, a No. 4 size, used through a small cysto-urethroscope, should be employed. Under such circumstances the danger of implanting gonorrheal infection in the kidney pelvis is remote. Moreover, an unfavorable soil is probably responsible for its clinical rarity. Gonococci flourish mostly on columnar epithelium.

For permission to publish these cases I am indebted to Dr. Robert V. Day.

DISCUSSION

DR. ANDERS PETERSON: Considering the great prevalence of gonorrheal infection in both sexes, we are at once impressed with the rarity of kidney involvement. That the infection takes place through the blood stream seems to me the most logical conclusion. We know that gonorrheal bacteriemia, joint invasion, endocarditis, etc., must take this route of invasion. The kidney undoubtedly possesses a high immunity and thus escapes involvement, though it is often exposed. No specific treatment has been evolved, but it is quite generally agreed that silver nitrate solution is the application of choice.

DR. D. BUIE GARSTANG: Gonorrheal infection of the kidney is indeed rare, not a great many cases have been reported to date. I have seen 2 cases which I am satisfied were positive. The first, about fifteen years ago, occurred in a young man who sought treatment for a typical acute posterior gonorrhea. A few days after coming under observation he complained of severe pain in the right kidney region accompanied by fever to 104°F. The pain was so severe that we decided to catheterize the ureter in spite of the urethral infection, and obtained a very purulent urine loaded with gram-negative intracellular diplococci. The renal pelvis was lavaged with 10 per cent argyrol. The renal pain was relieved and did not recur. We were rewarded for our efforts with a typical gonorrheal epididymitis, which subsided in about ten days, but the patient, relieved of his urethral as well as the renal pain, refused further treatment and disappeared.

The second case occurred in a young woman in April, 1923, one and a half years after a

gonorrheal infection, following a criminal assault, from which she had apparently made a good recovery. Her first symptom of renal infection was sharp pain in the left kidney accompanied by moderate frequency and urgency of urination. The bladder urine was very purulent with numerous gram-negative intracellular diplococci. Catheterized urine from the left kidney showed the same. Dr. Zeiler made several attempts to culture the organism without success, and concurred in the opinion that we were dealing with the gonococcus. She was treated till July by pelvic lavage with 10 per cent argyrol and 1 per cent silver nitrate weekly. The pus and diplococci gradually disappeared. On July 5, 1923 the bladder urine showed much pus and colon bacilli; no diplococci were found. The urine from the left kidney showed a few colon bacilli, very little pus and no diplococci. She was treated until September, the urinary sediment was frequently examined, the colon bacilli gradually disappeared, cocci were never found. Her highest temperature was 99.4°F. She was again seen in December, 1923, said she was feeling fine and refused to permit examination to determine if infection still existed.

I think Dr. Kessler has been fortunate in seeing so many cases of this infrequent kidney infection, and I agree with him, that until we are better able to culture the gonococcus, we will have to consider those cases gonorrheal in which we find an organism with its morphological and staining characteristics and resistant to ordinary culture methods.

DR. KESSLER, *closing*: Where obstruction to the urinary stream, either at the kidney pelvis outlet or in the ureter itself, is present and satisfactorily corrected, a cure is usually attained. Cases of gonorrheal pyelitis reported in the literature as "well" practically all had been treated with radical procedures. However, where there is no apparent obstruction symptomatic treatment is often prolonged and disappointing.

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[For remainder of References see p. 246.]

PUERPERAL GYNECOLOGY*

INCLUDING GYNOPLASTIC REPAIRS OF OLD LACERATIONS, PRIMARY CYSTOCELE, AND UTERINE FIXATION AT OR SHORTLY AFTER CHILDBIRTH†

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INTRODUCTION

REALIZING that very few women are able to go through labor without some resultant pathology, and that most of these suffer years of invalidism because of the difficulty of leaving their domestic duties and returning to the hospital for repairs, I attempted, in 1916, a procedure which I had been planning for a long time, i.e. to repair old as well as new lacerations of the genitalia shortly after childbirth.¹ In spite of my training in the conservative school, I was unable to accept the theory that this was impractical because of the edema, congestion, and friability of the tissues. The difficulty of recognizing the different anatomical layers was emphasized. The presence of the lochia and the dangers of infection were also feared.

I would like to mention here that some years after reporting my first series of cases, I learned that Dr. F. H. Stuart in 1906,² and Dr. A. A. Hussey³ in 1916, both of Brooklyn, reported work along this line, limiting themselves to the repair of the cervix and perineum. DeLee⁴ told me that he had tried to do some repair work in 1898. My work was done independently and without any knowledge of earlier attempts and includes many more types of operations. (Table 1.)

At first these repairs were done a week after delivery. The results were so satisfactory that the time between the delivery and repair was gradually shortened and in 1920⁵ I reported two cases that were satisfactorily repaired immediately after the expulsion of the placenta.

Since that time, encouraged by the study of the end results over a period of many years, it has become routine procedure for the obstetrical staff of Mt. Sinai Hospital of Cleveland to repair practically all old and new lacerations immediately or within a week after delivery.

In a series of 1326 cases, 1097 or 82.7 per cent were operated upon immediately and 207 or 15.6 per cent were operated upon between the third and sixth days. One patient who had refused operation changed her mind and was operated on the fourteenth day post-partum.

Immediate operation following delivery has many advantages over delaying the repair for several days.

(1) The patient is spared the added shock and fright, the double anesthesia and the second charge for the operating room.

(2) Her stay in the hospital is not prolonged.

(3) The infant does not miss any feedings.

(4) There is less danger of infection and morbidity. It has been proved that bacteria multiply very rapidly in the uterus and the vagina, beginning the third day post-partum.

(5) The cervix can be pushed toward the introitus immediately after delivery without much force, due to the complete relaxation of the supporting ligaments and the vaginal canal.

(6) The tender skin and mucous membrane are saved the irritation from repeated sterilization from iodine, etc.

(7) The tissues might be somewhat more edematous but are not quite as

* This is the first time that this term has been applied to gynoplastic repairs after deliveries.

† Submitted for publication February 3, 1932.

friable as several days later. With experience it is possible to recognize the anatomical structures, the amount of relaxation present and the extent of repair necessary.

Many do not examine the cervix on account of the danger of carrying in an infection, closing the cervix too tightly or the fear of lacerations or complications

TABLE I
TYPES OF OPERATIONS

	1922	1923	1924	1925	1926	1927	1928	1929	Total
C.....	...	1	1	...	4	...	...	...	6
T.....	29	25	26	20	16	17	8	6	147
P.....	43	46	43	58	63	43	59	34	389
3rd ^o .P.....	...	...	...	...	...	1	1	1	3
H.....	3	2	8	7	9	4	5	2	40
T.H.....	...	...	...	...	...	...	4	...	4
T.P.....	71	53	79	45	47	60	65	39	459
T.C.....	1	1	2	1	...	1	...	...	6
T.C.P.....	7	11	20	10	7	8	7	17	87
T.P.H.....	4	1	9	9	3	6	5	7	44
T.C.H.....	...	1	3	...	...	...	...	...	4
T.C.P.H.....	...	6	5	1	5	1	...	4	22
T.P.U.....	...	1	...	...	...	...	...	...	1
C.P.H.....	1	3	4	...	1	...	1	1	11
C.P.....	10	4	1	8	8	1	3	4	39
A.C.P.....	...	3	2	...	1	...	...	...	6
A.C.P.H.....	...	2	1	...	...	...	1	...	4
A.C.....	...	...	1	...	...	...	...	...	1
P.H.....	...	1	2	3	8	7	5	6	32
Amp.Ce.P.....	...	...	...	...	1	2	1	1	5
Vag.Fix.....	...	...	...	...	...	3	...	2	5
Caut.Ce.C.P.....	...	...	...	...	...	1	3	2	6
Caut.Ce.T.P.....	...	...	...	...	...	...	1	...	1
Bart.Cyst.....	...	...	...	...	...	1	1	1	3
Rect.Vag.Fist.3rd ^o .P.....	...	...	...	...	...	...	1	...	1
Total.....	169	161	207	162	173	156	171	127	1326

C., Cystocele. T., Trachelorrhaphy. P., Perineorrhaphy. H., Hemorrhoidectomy. U., Umbilical hernia. Amp.-Ce., Total amputation of cervix. A.C., Partial amputation of cervix. Vag.Fix., Vaginal fixation. Caut.Ce., Cauterization of cervix. Rect.Vag.Fist., Rectal vaginal fistula. Bart.Cyst, Bartholin cyst.

The repair of old lacerations may be delayed for one or more of the following reasons: first, after a very long labor or difficult delivery, additional shock or hemorrhage might be inadvisable; second, the presence of a suspected infection would certainly be another reason for waiting; third, operation is often delayed on patients who enter the hospital too late for complete preparation; fourth, if the operator lacks skill and experience in working rapidly, it might be advisable to postpone the operation rather than expose the patient to too prolonged anesthesia, shock and hemorrhage at the time of delivery.

occurring at subsequent deliveries. Personally, I feel that a torn cervix, regardless of how small the tear, rarely becomes normal in contour; it is always a source of danger as a focus of infection and as a seat for malignant degeneration. What was considered radical and dangerous a generation ago can now be done in safety, due to the remarkable progress that surgery has made and the improvement in hospital and nursing technique. Time, experience and improved methods have shown the comparative safety, advisability and benefits of this work to the mother, the family and the community. The mother leaves

the hospital in the best possible physical condition after her confinement, she is saved chronic invalidism and subsequent

factorily, and if neglected, it may cause numerous gynecological complaints and disabilities.

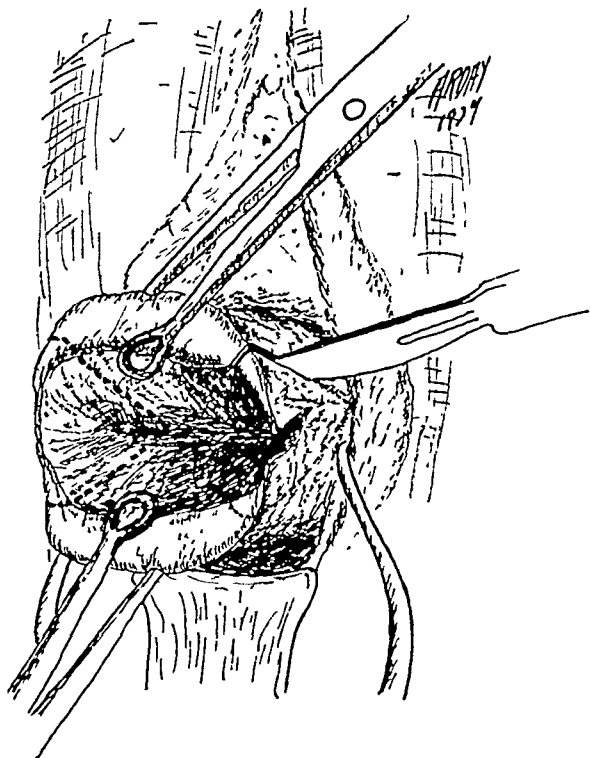


FIG. 1. Repair of cervix.

operations with the accompanying pain and expense.

INDICATIONS

There are very few women who do not develop some pathologic condition as a result of childbirth. In a series of over 5000 obstetrical cases admitted to the Mt. Sinai Hospital of Cleveland, from 1923 to 1930, 38.5 per cent of the multiparae were operated upon for old lacerations.

The remaining unoperated cases consisted of primiparae, cesarian sections, complicated deliveries precluding the repair work, multiparae who had been repaired before and were treated as primiparae, and some others who refused to be operated upon.

The extent of the lacerations or relaxation do not determine the operation. No laceration is small enough to be neglected. Nature rarely cures even the smallest satis-

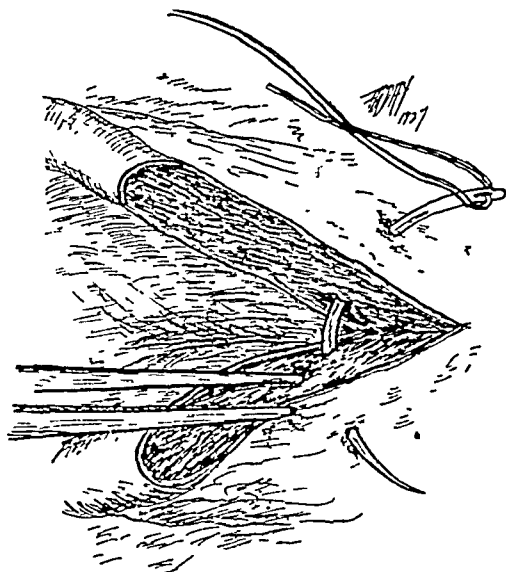


FIG. 2. Repair of cervix.

First, there are those of the cervix, which may result in eversion and hypertrophy. This may be the seat of an ascending infection into the uterosacral ligaments and the bases of the broad ligaments, into the walls of the uterus and into the endometrium. Infected Nabothian follicles, leucoplakia and cancerous degeneration frequently follow.

Second are lacerations of the anterior vaginal wall which may produce a cystocele or a urethral prolapse (so called urethrocele). The former, regardless of its size, may be a cause of attacks of trigonitis, cystitis, and ascending infections into the kidneys. The latter may result in a prolapse of the urinary meatus and urethral caruncle.

Third, lacerations of the posterior vaginal walls and perineal body are followed by rectocele, prolapse of the uterus and of the rectum. Hemorrhoids are frequent end results.

All these conditions lead to the well-known gynecological complications and complaints.

Another indication which is often overlooked is the effect of the patient's dis-

In many cases, low forceps were applied to help the fetal head past the pubic arch and to shorten the time of labor and delivery.

Subsequent deliveries are not usually complicated by the presence of scar tissue from previous repairs. If any lacerations occur, they are immediately repaired as in primiparae. Table III shows 3 cases of a large series of patients who were delivered after extensive repairs at previous confinements.

TECHNIQUE FOR LABOR AND IMMEDIATE REPAIR

There are certain prerequisites necessary for the success of the delivery and repair. The first to be considered is the prenatal care which should include a thorough history and physical examination. Fortnightly observation of the growth and position of the fetus and examination of the urine, blood pressure and weight should be

TABLE III

Name	Para	Date 1st Ex.	Delivery	Repair	Subsequent Examination	Remarks	Subsequent Deliveries	Later Exam.
M. H.	ii	2/10/21 Rel. +++ C. ++ R. +++ Lac. Ce.	6/23/21 Knee presentation. 13 lb. baby	T.C.P.	3 months — — — well healed		4/18/24 L.F. P.H.	18 mos. later in good cond.
J. K.	iv	10/2/20 Rel. ++ C. + R. ++ Lac. Ce.	11/1/20		5 weeks ± — ± good cond.	Aet. 44 years	9/15/23 Normal delivery. P.H.	5 mos. later genitalia in good cond.
R. L.	vii	4/21/19 Rel. ++ R. ++ Lac. Ce.	6/10/19 Normal	T.P.	5 years — good cond.	Aet. 42 years	3/10/24 Normal delivery.	3 mos. later genitalia in good cond.

Rel., Relaxation. C., Cystocele. R., Rectocele. Lac.Ce., Lacerated cervix. T., Trachelorrhaphy. P., Perineorrhaphy. L.F., Low forceps. H., Hemorrhoidectomy.

CONTRAINDICATIONS

There are few contraindications besides those generally spoken of in surgery. The presence of a known or suspected infection, extreme weakness, bad heart or kidney condition, the presence of a respiratory disease which prohibits a prolonged anesthetic, large vulvar varicosities, marked edema, post-delivery shock or hemorrhage, phlebitis, or a full stomach may be considered as temporary contraindications. Many of these patients can be prepared for operation either by entrance to the hospital several days before the delivery or the operation may be delayed until a favorable time.

made. The condition of the breasts, thyroid, and bowel movements are also observed. Bad teeth, tonsils, cervical infections, etc., are corrected if possible. Instructions are given about proper clothing, abdominal support and diet. Abstinence from intercourse during the last months of pregnancy is also advised. Old lacerations, hemorrhoids and other abnormal or pathologic conditions are noted for future consideration.

The delivery should take place in a well-regulated hospital where the strictest asepsis and antisepsis prevail. The obstetrician should have gynecological experience so that he can recognize the abnormal

from the normal. Proper light, assistants and instruments are paramount.

Assuming that the foregoing require-

be given until within a few hours of the expected time of delivery.

In order to conserve the strength of the

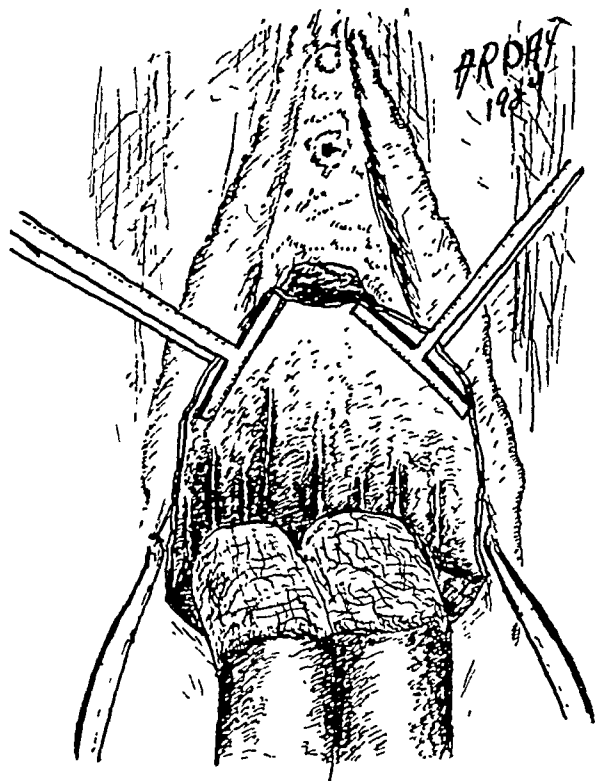


FIG. 5. Repair of the rectocele.

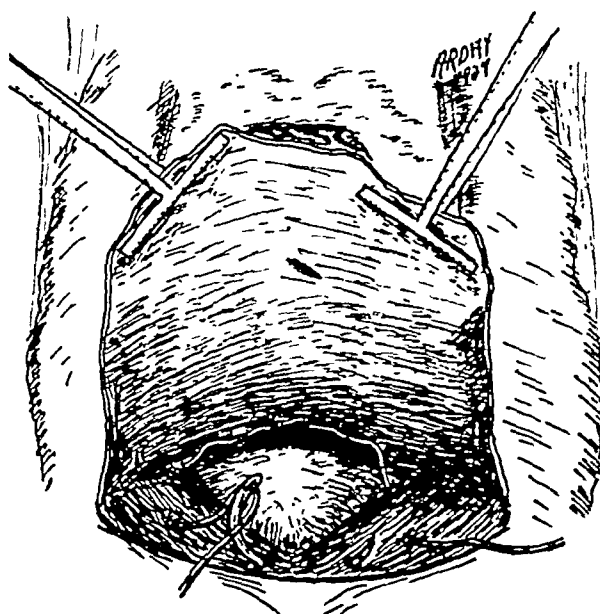


FIG. 6. Repair of the rectocele.

ments are fulfilled, the patient enters the hospital as soon as any spotting or bleeding occurs, if the membranes rupture before labor begins or when labor pains occur about ten minutes apart. This allows ample time for examination and preparation. Only rectal examinations should be made during labor. The dilatation of the cervix and the descent of the presenting parts can be readily determined in this manner.

The patient is then prepared as for a gynecological operation. The pubic hair is shaved, the vulva and the pubic regions are thoroughly washed with soap and water, and then irrigated with a mild antiseptic solution. If the patient is in the early stages of labor and the rectum is full, the patient may be given a cleansing enema, but this is not advised shortly before delivery for fear of a spill or contaminations. Small amounts of liquid may

patient, some form of analgesia and anesthesia are given when strong pains occur at five minute intervals, and the cervix admits two fingers. We have been using the so-called "twilight sleep," i.e. morphine and scopolamine technique in the early stages, augmented by ether and nitrous-oxygen, with or without ether in the later stages.

When ready for delivery, the patient is completely anesthetized with nitrous-oxygen or ether or both, depending on the type of delivery, the type of repair and the condition of the patient. She is then placed in the lithotomy position. The vulva, pubis, lower abdomen and upper thighs are thoroughly cleansed with soap and water, washed with sterile water and then sponged with 70 per cent alcohol solution by the nurse. The assistant then goes over the field with a 2 per cent iodine solution, followed by 70 per cent alcohol. The patient is then draped, especial care being taken to keep the anus covered. If the presenting part of the fetus is not too low, the bladder should be emptied by catheterization. To further conserve the strength of

the mother and baby, and also to shorten the length of labor, we do not hesitate to help the dilatation of the perineum by the hand, well lubricated with neutral sterile soap as advocated by Potter. The gloved hand and the vagina are frequently rinsed with 1 per cent lysol solution. Forceps deliveries, versions and pressure on the uterus from above are also done when indicated. (See Table II, Types of Deliveries.)

As soon as the head is delivered, 1 c.c. of pituitrin is injected into the biceps muscle of the patient and may be repeated two or three times if necessary. This causes the uterus to contract, expels the rest of the fetus, and decreases the placental site, thus hastening the third stage of labor and minimizing the loss of blood. After the expulsion of the placenta the mother is given an intramuscular injection of 1 c.c. of ergot. An intern or nurse keeps constant pressure on the fundus during the delivery and repair and for at least an hour afterwards. The patient is then redraped, the gloves are thoroughly washed in 1 per cent lysol or fresh gloves are put on and clean towels are placed in the obstetrician's lap.

EXAMINATION FOR NEW AND OLD LACERATIONS

If the patient's condition is satisfactory, the genitalia are then examined for new and old lacerations. With sufficient experience these can be readily recognized. We can, moreover, forestall the occurrence of subsequent cystoceles and rectoceles by doing primary repairs even where there is no external evidence of lacerations.

The technique of inspection consists of:

(1) The Gelpi-Bubis weighted speculum is inserted.

(2) The anterior and posterior lips of the cervix are grasped with ring-shaped sponge holders, one jaw of each being protected with rubber tubing.

(3) The uterine cavity is wiped with gauze soaked in 2 per cent iodine solution which stimulates the uterus to further contraction, cleans out the blood clots,

pieces of placenta or membranes and helps to sterilize the uterine cavity, the cervical canal and vagina.

REPAIR OF THE CERVIX

Nature seldom causes a complete cure and normal restitution of a cervix that has been lacerated. In my experience, I have found that almost all cervixes show lacerations even after the so-called normal deliveries. Even a small nick left unrepaired may lead to chronic eversion hypertrophy and infection both local and ascending, and subinvolution, etc. I have emphasized for years⁶ that it is safe to examine the cervix after delivery if done according to the rules specified, that no tear is small enough to neglect and that a tear of the cervix is more detrimental to the future health of the mother than a laceration of any other part of the genitalia.

Examination of the Cervix. Immediately after the delivery, the cervix can be readily brought down to the introitus for thorough examination by pressure from above and by pulling on the two sponge or cervix holders. This is also facilitated by the use of an angle retractor placed against the lateral wall of the vagina.

If the cervix is ragged or full of small cysts, a partial amputation may be done with the scissors, knife, cautery or curette. Any bleeding may be controlled by No. 1 chromic catgut sutures, either continuous interlocking or figure of eight.

Any tear more than 1 cm. deep should be sutured. Large tears are repaired as follows: The cervix holders are adjusted to grasp the cervix about 0.5 cm. from the tear and the cervix is pulled over to the opposite side. The angle retractor is then adjusted so as to give the best possible exposure. Old tears are easily recognized after some experience. The old torn surface and scar tissue of the posterior lip are removed by scissors or knife. The same is done to the anterior lip. These two surfaces are then united by interrupted or continuous interlocking sutures with No. 1 or No. 2 chromic catgut, care being taken to remove the

blood on the surface before each stitch, to insert the needle down to the mucous membrane of the cervix and to carry the suture to the very tip, otherwise a nick will remain which may cause future trouble. Any other tears are treated in the same manner. If the technique is carefully carried out, there will be no danger of closing the cervical orifice too tightly and thus interfering with the drainage.

REPAIR OF THE CYSTOCELE

There is some degree of cystocele present in all cases of procidentia and posterior displacements of the uterus. A perfect perineal body does not support the bladder or prevent a cystocele from causing trouble. If it does occur regardless of all precaution at the time of delivery and is recognized, it can be repaired immediately, as is illustrated in one of my cases, which was, I believe, the first of its kind to be recorded.⁷

The following procedure was adopted: a Gelpi-Bubis weighted vaginal speculum was placed in the vagina and the cervix was repaired with interrupted No. 2 chromic catgut sutures. A longitudinal incision was then made along the anterior vaginal wall starting at a point just below the urinary meatus and extending almost down to the cervix. The vaginal mucous membrane and the underlying tissue were incised, exposing the sagging wall of the bladder. The edges of the mucous membrane flaps were grasped with r-shaped forceps and separated from the bladder by blunt dissection as far as the pubic arch.

The pubovesical fasciae near the descending rami of the pubes were then brought together in the median line by several interrupted No. 2 catgut sutures. This gave a new and firm base to the urethra and the bladder. The excess of the vaginal flaps was then trimmed off and the edges were united by a continuous, interlocking No. 1 chromic suture, care being taken to prevent puckering of the anterior wall. The perineum was then repaired in anatomical layers with No. 2 chromic sutures. The patient made an uneventful recovery

and examination eight months after delivery showed perfect results. This patient was again delivered four and a half years later. Episiotomy followed by low forceps delivery was done. The anterior vaginal wall was not seen during the whole delivery and two months later examination showed that the patient was in perfect gynecological condition.

VAGINAL FIXATION OF THE UTERUS⁸

We have performed vaginal fixation of the uterus on six women who have suffered from the effects of third degree retroversions following their previous confinements. This can be done after the bladder has been freed from the cervix as in the cystocele operation, but raised higher with a retractor. The uterine muscle is anchored above the internal os to the pubovesical fascia with interrupted No. 2 chromic catgut sutures. Subsequent examinations of the cases showed the uteri in first or second degree retroversion, high in the pelvis and the patients reported great improvement in health.

REPAIR OF THE RECTOCELE

The repair of the perineum, so-called rectocele, depends on:

- (a) The extent and direction of the laceration
- (b) Whether there is a new laceration superimposed on the old one
- (c) The size of the hernial opening
- (d) The tone and size of the levator ani and perineal muscles.

The object of the operation is to remove the scar tissue, to cure the hernia, and to replace the various layers of muscles and fasciae in their respective positions. Many types of operations have been developed, but the following technique has given very satisfactory results.

Technique. All instruments, except the Gelpi spreader, are removed and the uterus is pulled back into its normal position by the insertion of the assistant's hand between the pubis and the uterus. Occasionally the uterus is shoved up per vaginam.

A curved incision is then made along the mucocutaneous border between the carunculae myrtiformes. If the line of cleavage is found, it is surprising how readily and with what little bleeding the mucous membrane may be freed from the surrounding tissues. The vaginal edge is grasped by Ochsner forceps (later replaced by a large r clamp), and the posterior wall of the vagina is freed from the muscles until a good exposure of the levator ani muscles is accomplished.

If the hernial orifice is small, it may be closed by a purse-string suture of No. 2 chromic catgut. If the orifice is too large, it is then closed by interrupted figure of eight or x sutures. The levator muscles are then brought together in the mid-line by either continuous or interrupted sutures. The excess and scar tissue of the mucous membrane are removed and the cut edges are brought together with a continuous, interlocking No. 1 chromic catgut suture. After removing the Gelpi retractor, the perineal muscles are coapted with either continuous or interrupted No. 2 sutures, care being taken, however, that no pockets are left and that the vaginal orifice is not closed too tightly. The edges of the skin are then united with continuous or interrupted sutures.

HEMORRHOIDS

A sterile towel or sponge is placed over the perineum and the anus and rectum are examined. If there are any edematous or enlarged hemorrhoids present, the sphincter ani is dilated, the hemorrhoids are either incised and the blood clots expelled or they are removed by knife and sutured with No. 0 chromic catgut. In many cases we have removed clusters of hemorrhoids by a modified Whitehead operation with very fine results.

DELAYED OPERATION

If the gynoplastic operation is done twenty-four or more hours after labor, the following technique is used:

The night before the operation, the patient, if nervous or restless, is given

20 to 30 grains of sodium bromide or 1 grain of luminal. One-half hour before being sent to the operating room, she is given a hypodermic injection of 1 c.c. of pituitrin to decrease the lochia. This is followed fifteen minutes later by a hypodermic injection of morphine sulphate gr. $\frac{1}{4}$ and atropine, gr. $\frac{1}{150}$. Under nitrous-oxide oxygen or spinal anesthesia she is prepared for the operation. The external genitalia and thighs are painted with a 2 per cent iodine solution, followed by 70 per cent alcohol. Great care is taken to wipe the vagina dry without traumatism and to swab it and the cervix thoroughly with a 2 per cent iodine solution, followed by alcohol. The bladder is then catheterized, and the operative procedure is the same as described.

POSTOPERATIVE CARE

As soon as the patient regains consciousness she is returned to her room and kept warm. An infusion of 1000–2000 c.c. of saline solution is given in the thighs or in the axillary space, or 500 c.c. of 5 per cent glucose are given intravenously if indicated for shock, weakness or excessive loss of blood. The patient is made as comfortable as possible, alleviating the pain with generous doses of codeine or morphine. A pillow under the knees and frequent changes of position add to her comfort.

Occasionally these patients are troubled with urinary retention. The various known remedies are employed first and catheterization is used as a last resort, followed by daily instillation of 2 oz. of 1:5000 neutral acriflavine solution or $\frac{1}{2}$ oz. of 5 to 10 per cent argyrol. Urotropin, potassium citrate, or other urinary antiseptics are used when indicated.

The bowel movements are kept soft with $\frac{1}{2}$ to 1 oz. of petrolagar or nujol. The patients are also given daily injections of 4 oz. olive oil after forty-eight hours when a hemorrhoidectomy has been performed. Castor oil, aromatic cascara, etc., are used when indicated.

The mother is given a liquid diet for twenty-four hours, then semi-soft with

plenty of fluids, and a full tray on the third to fifth day. The baby is nursed according to schedule, missing only one or two regular feedings after the delayed operation.

END RESULTS

Table iv gives a résumé of the end results of 151 private cases with findings

TABLE IV
RÉSUMÉ OF 151 PRIVATE CASES

Time after D. & R.	1st Degree Relaxation (or +)		2nd Degree Relaxation (or ++)		3rd Degree Relaxation (or +++)	
	No of Cases	Condi- tion after Oper	No of Cases	Results	No of Cases	Results
3 wks			1	1 P		
1 mo	3	3 P	5	4 P 1 Im		
5 wks	2	1 P 1 Im	5	3 P 2 Im		
6 wks			10	8 P 2 Im		
7 wks			1	1 P		
2 mos	8	7 P 1 Im	6	4 P 2 Im	4	1 P 3 Im
10 wks	3	3 P	3	1 P 2 Im		
3 mos	8	8 P	4	4 P	4	4 P
4 mos	5	5 P	3	1 P 2 Im	4	4 Im
5 mos	5	3 P 2 Im	3	3 P		
6 mos	2	2 P	5	4 P 1 Im	1	1 P
8 mos			2	3 P	3	1 P 2 Im
1 yr	7	3 P 4 Im	5	5 P	1	1 P
1½ yrs	2	2 P	2	2 P		
2 yrs	1	1 P	5	1 P 4 Im	1	1 Im
3 yrs	2	2 P	9	7 P 2 Im		
4 yrs	2	2 P	3	3 P		
5 yrs	3	3 P	4	4 P		
6 yrs			4	2 P 2 Im		
Total	53	+	80	+	18	= 151 cases

Summary { Perfect: 113 or 74.7 per cent Improved 38 or 24.5 per cent
D, Delivery R, Repair. P, Perfect results Im, Improved

from three weeks to six years after delivery and repair.

COMPLICATIONS

Of a series of 1353 cases, 616 had one or more complications; 737, i.e. 54.8 per cent, had an uncomplicated and uneventful convalescence. Many of these patients were delivered by junior men of limited experience and by resident staff members, which could account for quite a few of the complications.

Two hundred fifty-seven of these cases had so-called postoperative reaction.

Two hundred twenty-one cases or 16.3 per cent (Table v) showed complications that may be attributed to the delivery plus the gynoplastic repair.

TABLE V
COMPLICATIONS ATTRIBUTED TO GYNOPLASTIC REPAIRS

Cystopyelitis, infected perineum	4
Retained lochia	24
Retained lochia, congestion of breasts	8
Phlebitis	14
Sapremia, pyelitis, phlebitis	2
Pleurisy	2
Postoperative hemorrhage	5
Bronchitis	*19
Bronchitis, retention of lochia	2
Bronchitis, cystitis	3
Bronchitis, congestion of breasts	*3
Bronchitis enteritis	*1
Bronchopneumonia	6
Bronchopneumonia, cystitis	2
Septic pneumonia, strept. hemolyt., peritonitis	†2
Sloughing of perineum	2
Sloughing of hemorrhoids	1
Moderate shock	16
Severe shock	5
Anemia during convalescence i.e. below 3,500,- 000 R.B.C. 60 per cent Hgb.	36
Pelvic infection	†4
Mild infection	14
Paralytic ileus	1
Resuture	2
Edema of perineum	5
Ischiorectal abscess	1
Perforation of rectum.	2
Perforation of bladder	1
Metritis and parametritis	3
Pulmonary embolism	†2
Catheterized 3 or more days	27
Total	221

* Cause of complication uncertain.
† Two died.
‡ One died.

Five deaths (Table vi) occurred in a series of over 1700 cases to date (Jan. 1, 1932). The mortality percentage is less generally postpone doing so until their minor complaints have developed to such proportions as to demand a major opera-

TABLE VI
DEATHS

Name	Age	Para	Date of Admiss.	Type of Deliv.	Date of Operat.	Type of Operat.	Date of Death	Cause
M. S.	32	iii	7/25/23	Spontaneous	7/25	P.	8/3	8/1. Blood culture positive for Hemolyt. Strept. Fever began 7/27/23.
K. W.	42	vi	4/16/26	Transverse presentation V. & E. after 40 hrs. of labor.	4/21	T.C.P.	5/29	5/11. Vaginal I & D for pelvic infection Septicemia, septic bronchopneumonia 5/27/26. Blood culture positive for Hemolyt. Strept.
B. H.	39	v	7/ 1/27	Premature separation of placenta. Man. dil. cer., M.F. Pulse during delivery: 148. Cyanosis and vomiting.	7/6	T.P.	7/13	Pulmonary embolism 12 days post partum.
A. G.	40	iv	10/26/27	R.O.P. Sc., L.F.	11/2	T.C.P.	11/6	10/31. Slight cold. 11/2/27. Considerable bleeding during operation. 11/6/27. Pulmonary embolism.
F. B.	29	iii	3/14/28	L.F.	3/14	T.P.	3/30	Peritonitis, Strept. Hemolyt. Septic pneumonia.

Compare this with the report by C. W. Frank of New York⁹ (Table vii).

than 0.3 per cent, which is lower than the United States maternal mortality record.

TABLE VII
MATERNAL DEATHS⁹

	Year	Number of Cases	Number of Deaths	Per Cent Rate	Per Thousand
New York City... Nursery and Child's Hospital	1929	124,404	629	0.50	5.0
Woman's Hospital	1929	2,180	6	0.27	2.7
Lying-In Hospital	1928-9	2,713	26	0.95	9.5
Bronx Hospital	1929	4,653	21	0.45	4.5
	1927-8-9	2,268	6	0.27	2.7

ECONOMICAL PHASE

Many women find it financially impossible to leave their families and enter the hospital for gynoplastic repairs. They

tion. The expense, the help problem and the fear of the operation are all factors which hinder her from taking any definite steps. By doing the necessary gynecological repairs at the time of confinement, it has been possible to put these patients in much better physical condition and at the same time not prolong their convalescence to any great extent. It is our routine to keep the obstetrical or gynecological patients in the hospital from twelve to sixteen days, while the average stay for delivery and repair was 15.3 days, and 14.6 days after operation for delayed cases.

CONCLUSIONS

1. Very few women go through one or more childbirths without resultant laceration.

tions, scars and relaxations. Repairs, as indicated in this thesis, are done to prevent mild cases from becoming incurably chronic and to give the more severe cases relief and renewed health.

2. Contrary to previous teachings, the tissues and the extent of damage can be easily recognized, the lochia does not interfere with the healing of the tissues and the dangers of infection are very small if the strictest asepsis and antisepsis prevail.

3. It is safe and advisable to examine and repair the cervix after the delivery with the proper precautions. A torn cervix is more detrimental to the future health of the mother than a relaxed perineum.

4. Operative deliveries are not contraindications to repairs if surgical judgment and technique are used as outlined in the text.

5. Practically all types of gynoplastic repairs may be done after deliveries.

6. Subsequent deliveries are not often complicated by the previous repair work. These patients are treated as primiparae and any new tears are repaired immediately.⁸

7. There were 5 deaths in a series of over 1700 cases or a mortality of less than 0.3 of 1 per cent. This is lower than the accepted maternal mortality of the United States.

8. The maternal morbidity also compares favorably with other clinics where no gynoplastic repairs for old lacerations are done.¹⁰

9. In a combined series of private and ward cases (248) 74.4 per cent had perfect results and 24.6 per cent were markedly improved.

10. This procedure is a great financial saving to the patient and the community.^{11,12}

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[For Remainder of References see p. 220.]

* Continued from page 182.

INTESTINAL OBSTRUCTION

APPLICATION OF SOME OF THE NEWER PRINCIPLES EVOLVED FROM EXPERIMENTAL AND CLINICAL EXPERIENCE*

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THERE is no surgical catastrophe of the human body that is as complex and that requires as much judgment in the way of treatment as does acute intestinal obstruction. Experimental workers have failed to identify a "specific toxin of obstruction," but we owe these workers much valuable information relative to the factors which produce symptoms, as well as knowledge gained about profound chemical changes that may occur in the course of an acute ileus.

SIMPLE MECHANICAL OBSTRUCTION OF SMALL BOWEL

In high obstructions the initial symptoms are not due to absorption of toxins but to loss of digestive juices from vomiting and the failure to reabsorb the digestive juices which are normally reabsorbed in the lower small bowel and ascending colon. As the main function of the upper portion of the small bowel is to secrete and that of the lower small bowel to absorb, one can readily understand why the loss of digestive juices in high obstructions produces earlier and more acute symptoms than obstructions of the lower ileum. Furthermore the great secretory activity of the upper small intestine produces an earlier and more marked increase in intrainestinal pressure; this, coupled with the comparatively longer intramural veins in the upper gut, results in an earlier vascular embarrassment in the involved loops. This early increase in intrainestinal pressure which occurs in high obstructions is somewhat counteracted by the beneficent decompressing effect of the

stomach, which is able to distend considerably and empty itself by vomiting.

If a mechanical obstruction is not soon relieved, the venous and capillary stasis which result cause the escape of considerable plasma into the lumen and wall of the intestine and into the peritoneal cavity. This loss of blood constituents produces a condition similar to traumatic shock, namely a fall in blood pressure associated with a diminution in the venous blood volume return. The fall in blood pressure occurs first in the diastolic phase, followed soon by a fall in the systolic phase. Many symptoms which were formerly ascribed as being due to a "toxemia" are undoubtedly due to this "shock-syndrome" effect.

In simple mechanical obstruction of the small bowel, whether high or low, absorption of toxins is of little importance until the vascular embarrassment in the obstructed bowel from increasing intrainestinal pressure has become pronounced enough to produce necrotic changes in the mucosa due to lack of circulating blood.

That the loss of digestive juices is the important factor in the production of the first symptoms of simple obstruction of the small bowel and that the vascular disturbances in the gut that result from increasing intrainestinal pressure are the cause of the "shock" symptoms and still later of toxemia is proved by many experimental and clinical facts. Particularly striking is the following experiment of White and Fender:

A dog with a complete high obstruction, decompressing himself by vomiting, can be

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kept alive for a month provided that the loss of his digestive juices is compensated by reinjecting the vomitus into the bowel below the obstruction.

Loss of Cl and H₂O of the gastric secretion from vomiting and failure to be reabsorbed lower down because of the obstruction produce dehydration, hypochloremia and an increased alkali reserve (alkalosis). A high N. P. N. of the blood (especially of urea) occurs which is the result of dehydration.

Loss of pancreatic juice can occur in high obstructions either by back-flow into the stomach or by failure to be reabsorbed below the obstruction. It is also lost when decompression jejunostomies are performed. Loss of this juice causes death in a comparatively short time. The anion Cl and the cations Na, K and Ca and possibly certain hormone-like substances are lost.

The excess of fixed bases over Cl in the pancreatic juice results in a decrease of the alkali reserve (acidosis) when this secretion is lost. One must not lose sight of the fact that loss of chlorides from vomiting, tending to produce as it does an alkalosis, is sometimes counteracted by the loss of fixed bases contained in the pancreatic juice, with a resulting tendency to acidosis. Thus the CO₂ combining-power of the plasma may not show much alteration despite a profound loss of electrolytes and bases.

The pancreas secretes a hormone-like substance which is reabsorbed in the intestine and which seems to influence metabolic functions in the liver, particularly that of fat metabolism. Loss of this hormone-like substance results in cloudy swelling and fatty infiltration of the liver and later a necrosis of liver cells and atrophy of liver cords (Berg and Tucker).

A dog with a jejunal fistula, receiving normal NaCl to replace electrolytes lost, does not live as long as a dog with a jejunal fistula whose pancreatic juices are reintroduced into the jejunum, which proves that something besides loss of H₂O

and electrolytes kills these animals. Berg and Tucker suggest that the loss of the "hormone" that influences fat metabolism in the liver is an important factor.

OBSTRUCTION OF LARGE BOWEL

The large bowel with its ability to absorb water and its ability to expand under pressure rarely produces acute symptoms from an obstruction, with the exception of volvulus. As most obstructions of the large bowel are due to carcinoma, the diagnosis should not be hard to make and the method of surgical approach is well-defined.

STRANGULATION OBSTRUCTION

The clinical course is so rapid that hypochloremia, dehydration etc., do not have time to develop materially. As a result of the shock and toxemia the entire circulation is affected early. Tremendous splanchnic engorgement results, with a deficit in the peripheral circulation.

Hemorrhage occurs into the strangulated loop as well as the gut above and a bloody fluid collects in the peritoneal cavity. This loss of blood plays an important role in either initiating or aggravating the condition of shock.

A high blood N. P. N. occurs, probably from the action of toxins on body proteins directly, as well as from the profound circulatory changes and depression of kidney function. The adrenals apparently become depleted early.

ADYNAMIC (PARALYTIC) ILEUS

According to Alvarez this is not a paralytic ileus in the sense that the intestinal muscle has lost its ability to contract. He has been able to show that strips of muscle removed from the bowel wall of a case of paralytic ileus still possess the functions of contractility, rhythmicity and irritability.

According to Hotz it is the distention of gas which produces the injury to the intestinal muscle; at the same time the distention compresses the veins in the intestinal wall which normally carry off considerable

amounts of gas by diffusion, further aggravating the distention.

Adynamic ileus can be divided into three clinical groups:

(1) *Simple*: This is usually due to excessive splanchnic stimulation and irritation from undue manipulation of viscera and the post-cathartic inhibitions which are intensified by ether anesthesia. The excessive inhibition that results produces a condition of "paralysis" of the intestinal tube, or as Alvarez would say, a flattening or reversal of the normal intestinal gradient.

(2) *Peritonitic*: This is the most common form of adynamic ileus and is the result of localized or general peritonitis. Many surgeons are of the opinion that it is the ileus that causes death in peritonitis. Of course this is a disputed point, but no one of experience will deny the frequently excellent results that follow an early high enterostomy performed upon a case of paralytic ileus complicating a peritonitis that is spreading but has not become generalized.

The experiments of Arai indicate that the paralytic ileus of peritonitis is due to excessive inhibition resulting from irritation and stimulation of the splanchnics rather than to a paralysis of the intestinal muscle. He cut the splanchnics in normal animals and noted the increased peristalsis. He then produced peritonitis and found that it had no effect on the peristalsis and came to the conclusion that all slowing in peristaltic movements in peritonitis is due to excessive splanchnic inhibition.

Perhaps the observations of Handley, Alvarez, Arai and others may revolutionize our treatment of peritonitis. The treatment of today includes the use of morphine in large doses to produce rest of the bowel. According to Alvarez large doses of morphine frequently produce reversed peristalsis, or in other words exaggerate the "flat gradient" existing in the paralytic ileus of peritonitis. According to Dragstedt morphine produces an increase in intestinal tone and increased frequency of contrac-

tions, and the "interpretation of its beneficial action (in peritonitis) must be on some other basis than that of abolishing intestinal activity and putting the intestine at rest."

Early decompression by means of a jejunostomy, combined with paravertebral or intradural injections of novocaine to block the splanchnics, and especially the use of hypertonic saline solution intravenously to increase intestinal tone and propulsive motility may supplant the present-day physiologic-rest method of treating peritonitis. Is the surgeon who advocates the physiologic-rest treatment producing rest to the bowel by giving large doses of morphine?

As most cases of peritonitis start in the pelvis and most commonly from a gangrenous appendix, it is essential that a jejunostomy be performed before the peritonitis has become generalized. No attempt should be made to approach the area of peritonitis, for fear of opening the "flood-gate" that would hasten the production of a general peritonitis.

(3) *The post-obstructive* variety of adynamic ileus is probably a true paralytic ileus. The segment of bowel above an obstruction, injured by the tremendously increased intraintestinal pressure, is loath to regain its tone and motility after the obstruction has been released.

POSTOPERATIVE ILEUS

(1) Sudden unexplained vomiting occurring about forty-eight hours after an operation for acute appendicitis should immediately arouse the suspicion that a loop of gut has become "paralyzed" as the result of a localized peritonitis. Delay in performing an enterostomy in this type of case while waiting for an "abscess to turn up" is responsible to a certain degree for the mortality that still exists in the surgical treatment of acute appendicitis. A high Witzel enterostomy should be performed, but the field of the previous operation is to be carefully avoided. Any intraperitoneal abscess that

may result should not be opened until "coffer-damming" has occurred.

(2) Sometimes during the convalescence from an abdominal operation trifling adhesions of a mild healed peritonitis produce a matting of loops of bowel and multiple obstructions may result.

METHODS OF ABSORPTION OF TOXINS FROM OBSTRUCTED BOWEL

Absorption occurs (a) through the blood stream, and (b) transperitoneally, i.e. through the bowel wall into the peritoneal lymph spaces.

(1) *Blood Stream Absorption.* Some absorption of abnormal products probably occurs directly through the splanchnic circulation, but the main and frequently lethal absorption of toxins does not occur until the local circulatory changes have become so pronounced that the route of absorption must be through the bowel wall and thence into the peritoneal lymph channels.

(2) *Transperitoneal Absorption.* Increasing peristalsis and the accumulation of digestive juices and gases produces a gradually increasing intrainestinal pressure, with the result that venous stasis is followed by capillary stasis, and finally complete ischemia of the part results. It is in this latter stage that active absorption of toxic material commences.

IMPORTANCE OF TRANSPERITONEAL ABSORPTION

There are experimental and clinical facts to emphasize this:

(a) A gangrenous loop has no circulating blood, yet toxemia is most pronounced in this type of case.

(b) McIver and White found that cats with experimental volvulus of the small intestine died in about twenty hours. The only method that prolonged life, besides resection of the strangulated gut, was removal of the strangulated loop to the outside of the abdomen. Two

animals treated in this way lived three and five days.

(c) Costain found that dogs with intestinal obstruction and fistula of the thoracic duct lived much longer and recovered more promptly after release of the obstruction, than control dogs without such a fistula. (Normally many of the lymphatics of the peritoneum drain into the lymph channels of the diaphragm. It is likely that under the altered conditions existing in an obstructed gut, toxins enter the thoracic duct in an abnormal manner.)

(d) Murphy and Brooks produced a thoracic-duct fistula, then made a closed loop and injected material from the intestinal contents of a dog dead of obstruction. They next increased the pressure in the loop. The thoracic-duct fluid soon became blood-tinged. This material when injected into other animals caused toxemia and death.

(e) Stone and Firor demonstrated the toxicity of Ringer's solution in which had been suspended an inflated closed loop of intestine. (Wangensteen could not prove any toxicity in the bloody peritoneal fluid of a case of strangulation.)

(f) Strangulated inguinal or femoral hernia is not nearly as rapidly fatal as a strangulated internal hernia.

(g) Gatch's experiment: He was not able to find any sign of absorption of nicotine until the pressure in the closed loop reached about one-half the systolic blood pressure. With the loop outside of the abdomen there was no absorption when the intrainestinal pressure equalled the systolic blood pressure. If the loop, distended to the systolic blood pressure level, was again introduced into the peritoneal cavity an immediate absorption of nicotine occurred.

FOUR FACTORS THAT ENTER INTO PRODUCTION OF SYMPTOMS

Many symptoms that were formerly ascribed as being due to the absorption of

"toxins" have recently been shown to be due to other causes, such as:

(1) Disturbances of chemical equilibrium from loss of H_2O , Cl, fixed bases, etc., due to vomiting and failure of reabsorption beyond the obstruction.

(2) "Shock-syndrome" effects, due to splanchnic engorgement and stasis, dehydration and most particularly from local loss of blood plasma into the gut, gut wall and peritoneal cavity.

(3) Some nervous factor, according to Meek and Ivy and Kelley, enters into the production of symptoms. These workers showed that depression, anorexia and vomiting which occurred in dogs as the result of distention of a loop of gut could not be reproduced in another series of dogs when the loops had been previously denervated.

(4) Finally we come to toxemia, which is a rather late manifestation in all forms of obstruction excepting the strangulated types.

RELATION OF ADRENALS TO TOXEMIA OF INTESTINAL OBSTRUCTION

Even though it is purely hypothetical this relationship is worth considering.

Animals whose adrenals have been removed are more sensitive to the injection of various toxic substances than normal animals. It is probably the loss of cortex hormone that is responsible for this increased sensitivity to toxins.

Animals dead from intestinal obstruction show more or less characteristic changes in the adrenal glands (Cutting).

Is the excessive destruction of amino-acids which occurs in profound toxemia of obstruction responsible for the lack of certain amino-acids such as tryptophane and tyrosine, which are essential to the manufacture of the internal secretion of the adrenals?

The protective function of the adrenal cortex against injection of toxins suggests the use of cortin in the treatment of the toxemia of intestinal obstruction.

SUPPORTIVE TREATMENT

On the basis of experimental and laboratory findings the following supportive treatment is indicated:

Normally 7500 c.c. to 10,000 c.c. of digestive juices are secreted in twenty-four hours to be absorbed again in the lower smaller intestine. When one remembers that 70 per cent of the body tissues is composed of H_2O and that a loss of 10 per cent of this amount of H_2O proves fatal and when one realizes further that the ability of the body to hold H_2O depends upon the dissolved electrolytes, particularly NaCl, it becomes quite apparent that an obstruction of the small bowel can produce pronounced chemical changes in the body.

(1) *Indications for Use of Intravenous Normal Saline Solution.* The rapid dehydration and chloride depletion resulting from vomiting and failure of reabsorption of digestive juices are best treated by means of normal saline solution. When loss of chlorides is excessive, higher percentages of saline should be administered.

A high N. P. N. of the blood can occur as the result of dehydration. A marked fall in the N. P. N. occurs following the administration of normal saline showing that this excessive accumulation must be due to loss of chlorides, because it is uninfluenced by the administration of plain H_2O or dextrose solution.

It must be borne in mind that the increased supply of H_2O that follows the use of normal saline solution increases intestinal secretion as well as intestinal motility, both augmenting intraintestinal pressure. For this reason decompression of the blocked bowel should be done concurrently or soon after the administration of the normal saline solution intravenously.

(2) *Indications for Intravenous Dextrose Solutions.* In the preceding paragraph we mentioned that a marked fall in the high N. P. N. of the blood occurs when normal saline solution is given to combat the dehydration of vomiting and failure of reabsorption. One must not lose sight of

the fact that excessive destruction of body proteins with a resulting high N. P. N. can also occur as the result of the action of toxins (?) and from the profound disturbances of the peripheral and splanchnic circulation that occur in the shock-syndrome ileus. In these cases dextrose is superior to saline because it acts as a "protein-saver." Dextrose solutions possess definite diuretic properties which are also of benefit. There is also experimental evidence that indicates that a liver well loaded with glycogen is less susceptible to the effects of toxic agents.

The longer a case of obstruction has gone the greater the value of dextrose. In delayed cases it must be given at the rate of 75 gm. every two hours in order to supply enough calories to maintain basal heat production.

Whenever dextrose is administered in cases of ileus it should be given in normal saline, because dextrose definitely inhibits and NaCl stimulates intestinal motility.

(3) *Indications for Intravenous Ringer's and Hartman's Solutions.* When the loss of pancreatic juice is excessive as from high obstructions and from decompression jejunosomies, the use of Ringer's solution or better still Hartman's solution is indicated. The latter consists of NaCl, KCl, CaCl_2 and sodium lactate in proper proportions and thus contains the electrolytes and fixed bases lost from the pancreatic secretion and the sodium lactate is effective in combating any tendency to acidosis.

(4) *Indications for Intravenous Hypertonic Saline Solutions.* There are three distinct indications for the use of hypertonic saline solutions in the treatment of ileus: (a) The chloride loss is supplanted. (b) It increases markedly the intestinal tone and propulsive motility. The uncertain results that have followed the use of various drugs in the treatment of paralytic ileus is probably due to the fact that they increase the tone and non-propulsive contractions of the intestine. P. E. Reid and A. C. Ivy have shown that morphine and pilocarpine produce this effect, and they have been able to prove

that hypertonic saline solution increases the propulsive type of motility in a jejunal loop when the loop is manifesting subnormal propulsive motility. (c) Hypertonic saline solution has a pronounced effect on metabolism, especially when administered in larger amounts. Elevation of heat production follows its use and this is explained as being due to the fact that when the hypertonic saline solution enters the circulation H_2O is withdrawn from the tissues to render the solution isotonic. This withdrawal of H_2O from the tissues carries with it stored food materials which are converted into energy in the form of increased heat production.

In the toxemia and shock of ileus there is a diminution of venous blood return to the heart due (a) to escape of plasma from the blood into the tissues because of increased permeability of the capillaries and (b) to capillary stagnation. The reversal of the flow of fluid through the capillaries that follows hypertonic saline injections is advantageous. An intravenous injection of 100 c.c. of 15 per cent NaCl is capable of increasing the blood volume by 500 to 1000 c.c. The increased heat production should likewise be of benefit because the temperature in the early stages of ileus is often subnormal. The effect of hypertonic saline solution of reversing the flow of fluids, as well as its effect upon heat production, probably explains the apparent benefit that sometimes follows the use of saline in certain cases of acute ileus where dehydration and hypochloremia had not had time to develop. Because it increases intraintestinal pressure, hypertonic saline solution should never be used until after decompression of the gut has been started by the removal of the obstruction or by the performance of an enterostomy. Exceptions are certain cases of paralytic ileus that are not due to peritonitis where the use of 15 c.c. to 50 c.c. of 20 per cent NaCl usually suffices when accompanied by decompression of the stomach and duodenum by means of duodenal intubation.

In the paralytic ileus of a localized peritonitis the use of hypertonic saline solution should be accompanied by the performance of an enterostomy.

Because of their tendency to withdraw H_2O from the tissues, hypertonic saline injections should be followed by the use of large amounts of H_2O .

Because hypertonic saline has no effect upon the anal sphincters it is advisable to resort to the use of a rectal tube when administering this form of treatment.

(5) *Indications for Blood Transfusions.* In the acute cases of obstruction, especially of strangulation, the improper filling of the heart which results from the diminished venous-blood volume return is best met by giving blood transfusions. (Hypertonic solutions of dextrose in saline can be used too, although they are less effective than blood. A hypertonic solution of dextrose with its large molecule of sugar is apt to remain longer in the "leaky" capillaries than an isotonic solution, say of NaCl, with its smaller molecule.)

SURGICAL TREATMENT

In every form of mechanical obstruction there occurs formation of toxic material, but the rapidity of absorption is influenced by the amount of intrainestinal pressure. An experimental animal can live for weeks with a thousand times the lethal dose of toxin in an obstructed loop provided that the pressure in this loop is kept below the level where transperitoneal absorption occurs. Hence, with the exception of high obstructions where death can ensue from loss of H_2O and electrolytes, it is our duty to overcome as early as possible the conditions which favor the increase in intrainestinal pressure.

(1) *Removal of Obstruction.* In early cases this is all that is necessary to accomplish the desired result. If much manipulation be required to remove such an obstruction, it is advisable to refrain from doing anything more than an enterostomy. Laeven has shown in animals with experi-

mental ileus of twenty-four hours' standing that stroking and "milking" of the gut above an obstruction resulted in a marked fall in blood pressure.

(2) *Relief of Gas Pressure.* Since normally large amounts of gases in the intestine are reabsorbed into the blood stream by the process of diffusion and since putrefaction results from stagnation of intestinal contents, it is readily understood that disturbance of the splanchnic circulation as well as the block in the intestine must result in the accumulation of considerable gas, with the resulting distention and relaxation of the intestinal musculature. Since gas is not easily propelled, especially when intestinal contractions are disordered, it is seen how imperative it is to eliminate these gases. Frequently the gases accumulate nearest the obstruction, whereas the liquid contents accumulate a little higher up. It is the accumulation of gas, rather than fluid, which so profoundly affects the blood flow through the bowel wall. When the gas pressure equals the systolic blood pressure, complete ischemia of the part occurs and gangrene may result, first manifesting itself in the villi at the antimesenteric border. Often, as a result of distention, kinking and lengthening of the intestinal tube, multiple "gas-traps" are formed. An original simple obstruction is thus converted into a case of multiple obstructions. These "traps" are best handled by puncturing them with the finest hypodermic needle. Great care must be exercised in avoiding leakage of fluid by introducing the needle only through the thickness of the thinned-out gut wall and by withdrawing it quickly after the gas has escaped. One mattress stitch of the finest silk should be introduced before the puncture is made and tied as the needle is withdrawn. A fresh needle should be used for each puncture. When all of these precautions are observed intestinal fluid cannot escape and the dangers of producing a peritonitis are avoided.

(3) *Exteriorization.* Exteriorization with immediate application of clamps above

and below the seriously damaged gut of strangulation or advanced simple mechanical obstruction is imperative.

We would like to emphasize that in many cases of simple mechanical obstruction the intestine immediately proximal to the point of obstruction becomes seriously damaged as the result of the circulatory stasis from increased intrainestinal pressure. It is these cases that are often a great problem to the surgeon because of the doubtful viability of the segment of gut. *When in doubt it is advisable to exteriorize* and thus avoid the dangers of peritonitis resulting from perforation of a gangrenous area.

No attempt should ever be made to do a resection and immediate anastomosis in any case of seriously damaged gut of strangulation or simple obstruction.

The exteriorized gangrenous gut is removed by a cautery, but the clamps are to remain on both limbs of the loop for at least twelve hours, until the adhesions have formed between the gut and peritoneum, thus preventing leakage of highly infective contents into the peritoneal cavity. The distended gut above the obstruction is next decompressed by means of a high enterostomy. The tube, which should be of soft rubber, can often be introduced a considerable distance without manipulation of the intestine. In twelve hours the clamp is removed from the two limbs of the loop that had been exteriorized and cauterized and the proximal limb is connected with the distal limb by means of a short curved glass tube. The tube leading into the high enterostomy can be withdrawn for a considerable distance after decompression has been obtained and feeding commenced as in jejunal alimentation. The digestive juices are thus being saved and the intestinal flow has been temporarily re-established. At a convenient time the last two stages of a three-stage Mikulicz operation can be performed upon the two segments that represent the limbs of the exteriorized loop.

(4) *High Enterostomy.* We would like to stress the importance of doing a high enterostomy through comparatively healthy gut. Alvarez says: "It is well-known that in acute ileus the bowel for some distance above the obstructed and highly irritated segment is empty; food residues are held back in the duodenum and jejunum and *if an enterostomy is to do any good the opening must be made far orad in the region of the gut where material has accumulated.*" The greatest drawback to a high jejunostomy has been the loss of pancreatic juices. The loss of electrolytes and fixed bases contained in this secretion can be controlled by the use of saline, Ringer's and Hartman's solutions. The loss of the "hormone" contained in the pancreatic juice that probably affects the fat metabolism in the liver is not serious unless the secretion is permitted to escape for a number of days. *In order to avoid the loss of pancreatic secretions the surgeon should make the necessary provisions so that alimentation can be started through the enterostomy as soon as it has completed its function of decompression.*

We have already described measures to insure alimentation in cases where exteriorization of gangrenous gut is done.

In cases of simple mechanical obstruction of the upper bowel that require decompression but do not need exteriorization we advise doing also an enterostomy of the collapsed bowel below the obstruction in order to permit of alimentation. A loop of the collapsed gut is sewed into the lower end of the laparotomy wound and in twenty-four hours it is opened by means of a trocar and a small catheter is introduced through the cannula. The contents above the obstruction can then be transported through the decompression enterostomy to the enterostomy beyond the obstruction by means of a catheter and syringe or the feeding pump.¹ Alimentation can be continued until such a time as

¹ This pump is described in my article: Treatment of certain cases of duodenal ulcer by jejunostomy. *Am. J. Surg.*, 15: 105, January, 1932.

further reconstructive surgery of the bowel may be necessary.

ADVANTAGES OF HIGH ENTEROSTOMY

An enterostomy performed in comparatively healthy bowel well above the obstruction possesses these advantages over an enterostomy in a markedly distended loop:

(1) *Slower decompression* occurs with the performance of a high enterostomy. A sudden release of large amounts of fluid and gas sometimes results in a severe aggravation of symptoms.

(2) *There is less liability of leakage* when a Witzel enterostomy is done in comparatively healthy bowel. Rubber-covered clamps can be used and the contents of the segment aspirated before introducing the tube.

(3) *The contents are less infective.*

(4) *Manipulation of distended, diseased bowel is avoided.*

(5) *More efficient decompression is obtained* when the tube is inserted higher and permitted to extend caudad for a considerable distance, than when it is introduced into a paralyzed, distended loop. Decompression is further enhanced by using the suction feature of the electric pump.

CHOICE OF ANESTHETIC

(1) *General anesthetics* such as ethylene, nitrous oxide and ether are contraindicated in the surgical treatment of intestinal obstruction. The two former, ethylene and nitrous oxide, do not give the necessary relaxation to permit of any kind of surgical intervention in an abdomen usually tremendously distended. The "mauling" of the intestine that is bound to result augments the toxemia.

Ether, even though it affords considerable relaxation, is contraindicated for the following reasons: (a) Danger of aspiration pneumonia unless continuous gastric drainage is used. (b) There is a diminished vital

capacity of the lungs in ileus cases due to bowel distention and as a result pulmonary complications are more likely to result when ether is used. (c) Ether is dangerous in shock. Animals anesthetized with ether withstand only $\frac{1}{10}$ the lethal dose of histamine. (d) Ether lowers or reverses the intestinal gradient very markedly. (e) Many patients while being etherized are likely to swallow considerable amounts of air which is certainly undesirable in cases of intestinal obstruction. While recovering from the effects of ether there is often considerable retching and vomiting, both of which are associated with swallowing of air.

(2) *Spinal anesthesia* has many advantages over ether. Its greatest advantage lies in the relaxation it affords, as well as the contracted state of that portion of the bowel whose circulation has not been seriously interfered with. As a result less difficulty is encountered in examining the abdomen and less manipulation of the bowel is required. In contradistinction to ether which lowers or reverses the intestinal gradient, spinal anesthesia because it paralyzes the splanchnics enhances the intestinal gradient, which is desirable in treating most cases of ileus. The greatest disadvantage of spinal anesthesia is the tendency for the blood pressure to fall, which likewise is a condition that prevails in many cases of obstruction.

As long as the blood pressure is not immoderately low when the spinal anesthesia is started, the fall in pressure can be met by the preliminary intramuscular injection of ephedrine, intravenous injections of 10 per cent dextrose in normal saline, CO₂ inhalations and by keeping the patient in the Trendelenburg position.

(3) *Abdominal Block Anesthesia.* If the blood pressure is unusually low as a result of severe intoxication, spinal anesthesia is definitely contraindicated. The condition of this type of patient certainly would not permit of any surgical intervention other than decompression by enterostomy, which can be performed under local anesthesia.

SUMMARY

1. In simple mechanical obstruction of the small bowel, particularly of the duodenum and jejunum, the earliest symptoms are due to dehydration and other chemical changes in the blood and tissues from loss of electrolytes and fixed bases due to vomiting and failure of reabsorption of digestive juices in the lower bowel.

Shock-syndrome effects and some nervous factor connected with distention of the gut are important in the production of symptoms of intestinal obstruction.

Toxemia ordinarily does not play a rôle in these cases until the intrainestinal pressure has increased to the extent of seriously impairing the circulation in the involved segment of bowel, thus producing gangrenous changes in the mucosa.

2. Paralytic ileus is most frequently due to peritonitis. The inhibition of function of the gut is due to excessive splanchnic irritation. As a result of the inhibition, the intestine distends from the accumulation of gas and liquids. Re-establishing the normal gradient by blocking the splanchnic stimulation, using hypertonic saline solution freely to stimulate peristalsis, and decompressing the distended intestine by a high enterostomy, are recommended.

3. In strangulation obstruction, the profound local circulatory changes result in an early and serious toxemia and shock. Whether the toxemia is due to an enterotoxin or to liberation of toxic substances from gangrenous patches in the gut, has not been settled.

It is a clinical fact that the intestine immediately proximal to a simple mechanical obstruction, as well as the markedly distended loops in paralytic ileus, often shows serious damage to the gut wall as the result of the tremendous increase in intrainestinal pressure. Treatment then becomes the same as for strangulation obstruction, namely exteriorization when possible and decompression by enterostomy.

4. The possibility of gas-traps resulting from a primary, simple obstruction because of lengthening and twisting of the intestinal tube must be borne in mind and surgical treatment is to be directed toward overcoming these multiple obstructions.

5. The advantages of a high enterostomy with the introduction of a soft tube for a considerable distance and the production of slow decompression by means of suction from an electric pump are stressed.

6. Conservation of pancreatic juice, particularly when jejunostomies are performed, is desirable, and methods of accomplishing this are described.

7. Blood transfusions, hypertonic and normal saline, and dextrose solutions are definitely indicated in the treatment of various forms of ileus.

The effect of hypertonic saline solution on peristalsis and the effect of the large amounts of water contained in normal saline and dextrose solutions upon intestinal secretion are to be borne in mind. They increase intrainestinal pressure and for that reason decompression should accompany the introduction of these solutions whenever conditions permit.

8. The unsatisfactory results that have followed the use of various drugs to stimulate peristalsis are probably due to the fact that they stimulate certain forms of intestinal contractions, but they do not increase propulsive movements. That hypertonic saline solution does increase these latter movements has been shown both experimentally and clinically.

9. The many disadvantages of ether and the advantages of spinal anesthesia are discussed.

10. The fall in blood pressure which occurs with spinal anesthesia, and which can usually be prevented, is due to a dilatation of the smaller vessels of the skin, muscles and splanchnic areas and is not due to a diminution in circulating blood volume as occurs in shock.

A SIMPLIFIED TYPE OF ROENTGEN PELVIMETER*

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MATHEMATICAL CALCULATIONS

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ROENTGEN pelvimetry is no longer a new subject and the object of this writing is not to enter into any detailed account of the technique of this procedure or to discuss the gradual growing use or value of this modern method of taking pelvic measurements. Suffice it to say, that those who have been accustomed to its use well know its superior value over any of the older methods. They also recognize its simplicity as well as its valuable accuracy.

In England and in America considerable work has been done with roentgen pelvimetry in the past two years. In our own country, in my opinion, the best work along these lines has been done by Dr. Herbert Thoms of New Haven, and Dr. Julius Jarcho of New York City.

Dr. Herbert Thoms has written several articles dealing in some manner or other with the subject over the past several years, some dating as far back as 1922. The last article of his, with which I am acquainted, appeared in May, 1929.¹ In this article he discusses the subject in a very concise and explanatory manner, describing in detail the type of roentgen pelvimeter he uses and also the technique of the procedure.

Dr. Julius Jarcho's latest article on the subject appeared in November, 1931.² He goes into the subject with considerable detail and brings out what I consider an

important fact in the technique of taking the roentgenograms. His procedure is to have the plane of the superior strait of the pelvis parallel to the film and it is especially in this type of a procedure that the pelvimeter I am about to describe is best adapted. In his procedure he also uses a Bucky diaphragm which, in my opinion, should be used to get the required detail when the patient is placed in the semi-upright position, giving the pelvic strait the parallel position as before mentioned.

To any one interested in the subject these two articles will give a very concise and detailed account of the method of doing roentgen pelvimetry.

Thus far, the roentgen pelvimeter described by recent authors has consisted of a lead plate mounted on some sort of a board which in turn was mounted on uprights or legs. The latter can be raised or lowered to any desired position which would bring the lead plate to the same level as the region which was to be measured. The lead plates used and described have been of various thicknesses. Some are permanently mounted and some merely placed on top of the board as described above. However, they all consist essentially of a moderately thin lead plate large enough to cover a 14 X 17 inch x-ray film. These plates are entirely covered with small perforations 1 cm. apart and arranged in rows at right angles to each other. This gives a piece of lead covered

¹ J. A. M. A., 92: 1515, 1929.

² AM. J. SURG., 14: 419, 1931.

* Submitted for publication, March 10, 1932.

with squares, the side of each square being 1 cm. long with the corner of each square represented by a small perforation through the lead screen. In a lead plate covering an area of 15×18 inches, which is the average size of most pelvimeters described, it is necessary first to accurately measure off all of these squares and then drill or punch holes at the intersection of all of these lines. In a screen the size mentioned above this necessitates the drilling of 1803 holes. It is an extremely tedious procedure not only to drill this number of holes but also to get them accurately spaced. If one hole is out of place then four other distances are in error. The object in having this innumerable number of holes in the lead screen, which in turn show as dots on the exposed film, is to enable one to have a scale at the desired region to be measured, rather than to apply the region to be measured to a scale.

In the theoretical use of this type of pelvimeter one would imagine that, due to the fact that the x-rays are sprayed from the focal point of the x-ray tube in the form of a cone, as one moved away from the center of the film, the space between the dots in that region would be greater than the space between the dots near the center of the film. In the practical use of this method of roentgen pelvimetry I have always noticed that the dots on the film seem to be an equal distance from each other whether they were measured near the center or near the periphery of the film. This was noticed naturally in cases taken in the manner described by Jarcho where the lead plate was superimposed parallel to the film. I had always imagined and I believe others have also, that as one approached the edge of the film the space between the dots would become greater.

I discussed this matter with Prof. E. B. Skinner, head of the department of mathematics at the University of Wisconsin, and he wrote me as follows: "I found the problem a rather interesting one as I had supposed that if you took the images on the

film corresponding to a set of perforations of the plate which lie on the straight line that the distances of the successive points

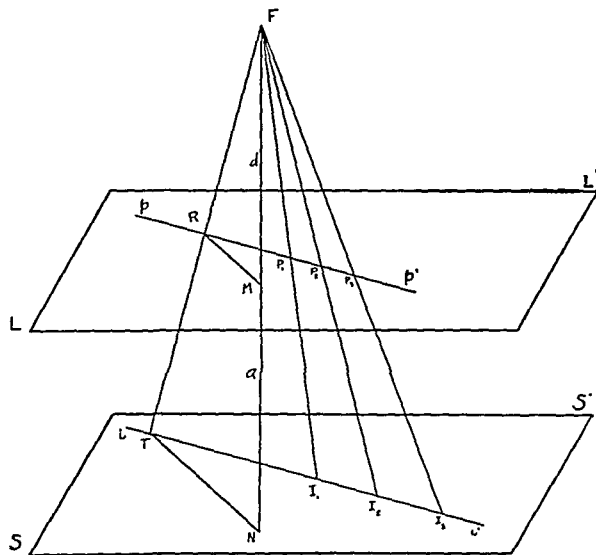


FIG. 1. Mathematical diagram.

on the film would increase as one goes out from the center of the cone. I find very much to my surprise that they do not increase, but that the distance between the images on any straight line are equal throughout the entire length of the line. Of course, if the spaces between any four neighboring points on the plate are equal, you could set up any number of lines which would have perforations equally spaced, and these would again appear as equally spaced points on the film. You are entirely correct in your surmise that any two pairs of equidistant points on the lead screen will appear on the film as two pairs of points equally distant. It does not make any difference as to the location of the points on the screen or the direction of the lines joining them."

Prof. Skinner then submitted the following, namely, that when a lead screen such as described was superimposed parallel to an x-ray film and an exposure made, all the dots appearing on the film along all the lines will be an equal distance apart.

Let F be the focus of the x-ray, LL the lead screen, and ss' the film parallel to the screen. If the film is perforated so that each of four neighboring perforations is at the

vertices of a square, a line pp' (Fig. 1) drawn through any two perforations of the screen will go through other perforations of

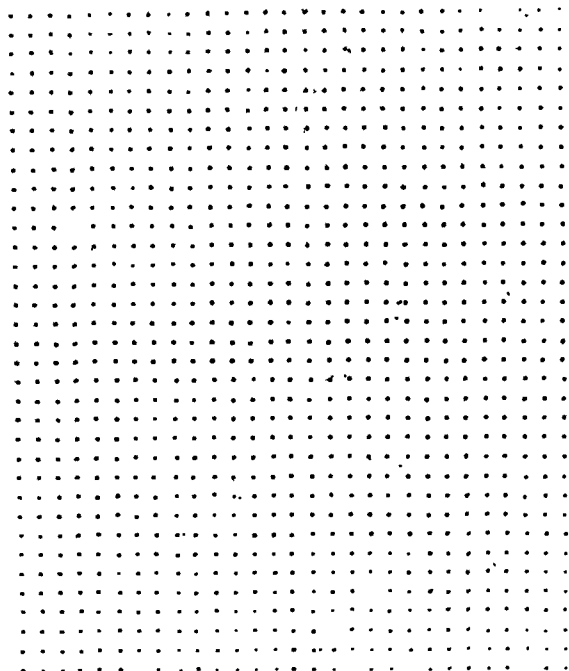


FIG. 2. Type of scale superimposed on film as made by present type of roentgen pelvimeter.

the network and the perforations on this line will be equally spaced since they are at the vertices of equal rectangles.

I. Let P_1, P_2, P_3 be the perforations along the diagonal line pp' of the screen, and I_1, I_2, I_3 their images on the film. Then *the images I_1, I_2, I_3 are equally spaced along the line ii' of the film.* For the triangles FP_1P_3 and FI_1I_3 are similar and the line FP_2I_2 which bisects P_1P_3 must also bisect I_1I_3 ; that is, $I_1I_2 = I_2I_3$. From this fact it follows that any pair of equal lines on the screen would reappear as a pair of equal lines on the film. This enables us to say that any configuration on the screen is reproduced exactly, so far as shape is concerned, on the film, and that the images on the film of all lines on the screen will be enlarged in the *same* ratio.

II. To find the ratio of enlargement, we draw the line FM perpendicular to the screen cutting the screen at M and the film at N and also draw the line FR perpendicular to the line pp' . This line extended will cut

the line ii' at a point T and will be perpendicular to it at that point. Let $d = FM$ be the distance from the focus to the screen and $a = MN$ the distance between the screen and the film.

The triangles FMR and FNT are similar with right angles at M and N . It follows that $\frac{a + d}{d} = \frac{FT}{FR}$. But from the pairs of similar triangles FRP_1 and FTI_1 and FP_1P_2 and FI_1I_2 , we have

$$\frac{FT}{FR} = \frac{FI_1}{FP_1} = \frac{I_1I_2}{P_1P_2}.$$

Then the ratio of enlargement is given by

$$\frac{I_1I_2}{P_1P_2} = \frac{a + d}{d} = 1 + \frac{a}{d}.$$

It follows that

$$I_1I_2 = \left(1 + \frac{a}{d}\right)P_1P_2.$$

The last equation enables us to compute the distance between any two image points on the film as soon as we know the distance between the corresponding perforations on the screen provided we know the distances of the screen and the film from the focus F .

For example, if the distance of the screen from the focus F is 30 inches, and the distance between the screen and the film is 6 inches, the length of any line l on the film will be

$$l = \left(1 + \frac{6}{30}\right)s = 1.2s,$$

where s is the distance between the corresponding points on the screen.

Since it is proved that under the conditions described, all dots on the film are an equal distance apart, as shown on Figure 2, it then follows that any row of dots could be used as a scale for all the measurements made in that plane. Therefore, there would be no necessity of using the innumerable dots which make up the scale covering the entire surface of the film. Instead of using the row of dots immediately in the region to be measured it is only necessary to transpose the region to be measured to the single scale and note the reading.

In the pelvimeter scale described all rows of dots have been eliminated except one line extending lengthwise through the

such as in the technique described by Jarcho, the measurements can be made on either scale and on any part of the scale.

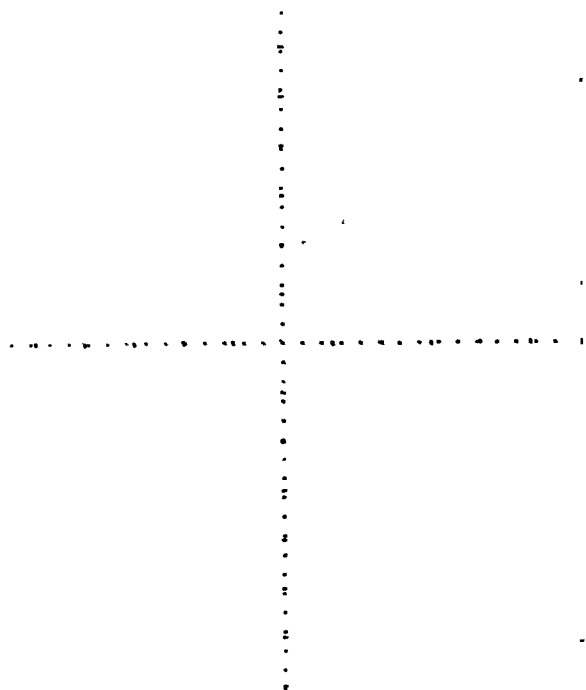


FIG. 3. Type of scale superimposed on film as made by simplified type of roentgen pelvimeter.

center of the lead plate and across line, such as is shown in Figure 3. If the pelvimeter were always used parallel to the film it would not be necessary to have more than one line of dots. However, if the pelvimeter is used on a slant, as in the manner described by Thoms, then it also becomes necessary to have a cross scale. This cross scale is so placed that the two lines of dots intersect each other at right angles in the center of the pelvimeter. If the pelvis is centered over the film when the radiograph is taken and the pelvimeter centered over the film when the scale is superimposed, then the scale will center near the middle of the superior opening of the pelvis. Then if the anteroposterior diameter is measured on the longitudinal scale at the same level of the scale and the transverse diameter measured on the transverse scale, the pelvimeter can be used in cases where the superior strait of the pelvis is not kept parallel to the film. However, in cases where the superior strait is kept parallel to the film,

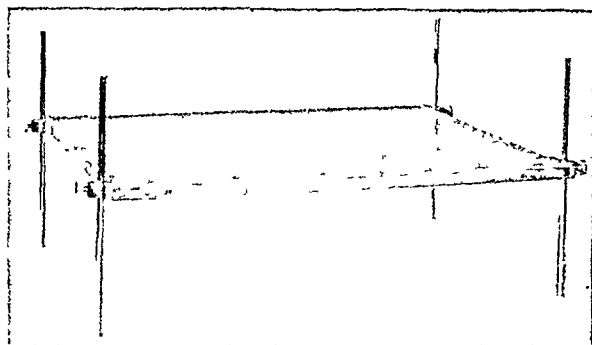


FIG. 4. General design and appearance of roentgen pelvimeter described.

This pelvimeter, as shown in Figure 4, has been constructed with four legs instead of the conventional type with two legs and feet, as used in the ones previously described. When used with a 14 × 17 inch cassette, these four legs just come over the edge of the cassette and therefore it is not difficult to center the scale on the film, in fact, it is almost impossible to do otherwise. When used with the Bucky diaphragm, the longitudinal and the transverse lines of the pelvimeter can be placed over the corresponding lines of the Bucky diaphragm and this will give a very accurate centering of the scale on the film. The legs and attachments have been made very accurate and the legs run very smoothly through the holes so that when the pelvimeter is held in position and the thumb screws loosened, the legs drop easily to the desired level. The lead plate used in the construction of this pelvimeter is very thin, being only 1/64th of an inch thick. The reason for using lead of this dimension is that the holes can be punched with a needle instead of drilled because punched holes in thin lead can be made more accurate than drilled holes in heavier lead. Punched holes can also be made smaller than drilled holes and will give a more accurate scale and one with less larger dots. The lead plate is mounted permanently with brass bands and screws to the wooden board which is constructed with a stile at each end to

prevent warping. When thin lead is used it is necessary to mount it permanently on the board in order to prevent it from bending and getting out of shape.

This type of pelvimeter, I believe, has several advantages over the older type. Due to the fact that it was made with a one line scale with very few holes in proportion to the number of holes on other pelvimeters, it is much easier and much less tedious to make; in fact, when made with thin lead as described and with the holes punched with a needle, the making of the scale is a very minor part of the procedure. In the construction of this type of pelvimeter there is very little measuring to be done and with punched holes and thin lead the scale can be made very accurate. Due to the fact that all measurements are made by applying the distance to be measured to the scale, oblique measurements can be made as easily as any other. In the use of this type of scale there is not the disfigurement of the film by the innumerable dots superimposed by other types of pelvimeters. This type of pelvimeter also permits the use of a

double scale. It will be noted in Figure 3 that along the lines of the scale are placed double dots which represent inches, and readings, therefore, can be made in inches as well as in centimeters. It is also possible with this type of single line scale to superimpose more than one scale on the film and thereby take measurements at more than one level. In the procedure such as described by Jarcho, when pelvic measurements are made at the same time head measurements are taken, then both can be made on the same single film by superimposing a second scale at the level desired merely remembering which scale is to be used for each measurement.

While the changes in the roentgen pelvimeter here described are not radical changes over the older type; they still are of such a nature that the manner of construction and use of this type of pelvimeter is somewhat simplified. Therefore, I believe that anything of this nature which might enhance this type of work among radiologists and physicians in general is worthy of consideration.



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*Continued from p. 205.

ROUTINE METHOD OF ARTIFICIAL RESPIRATION FOR THE SURGICAL CLINIC*

W. WAYNE BABCOCK, M.D., F.A.C.S.

PHILADELPHIA

ASPHYXIA during an operation, as a rule, is not conveniently or effectively treated by the routine methods of artificial respiration. Measures used in civil or industrial practice are adapted to the patient on the floor or ground rather than to the one on the operating table. The surgeon does not care to climb upon the operating table and bestride an open abdomen for the Howard method even though the viscera are covered by towels, or much less to invert the patient for the procedure of Schäfer or Marshall Hall. The arm movements of Silvester interfere with venoclysis and observations as to the movement of tidal air to and from the thorax. The tongue traction of Laborde is unreliable and if used, a dangerous delay in adopting adequate measures for artificial respiration may result.

In the surgical emergency there should be no delay, and the patient should remain on the operating table with the least possible change in position. The method should be positive and effective, and the manipulations used should not prevent convenient access to the mouth and jaws to maintain an open airway, to constantly record the tidal air movements and to give, if desired, inhalations of ammonia, oxygen, carbon dioxide or other substance.

Artificial respiration is not a gesture, it is an effect; and the surgeon should have constant evidence of its effectiveness. It should be feasible without producing infection, or causing other danger through an open abdominal cavity. It should not interfere with a coincident intravenous injection into a vein of the arm. If possible, it should permit the associated use of cardiac massage. The danger of fracture

of the ribs from undue pressure upon the thorax should be minimal.

It is our observation that in the operative emergency, the surgeon usually resorts to the Silvester method, driving the anesthetist from the patient's head, as the patient's arms are moved violently up and down; thus a careful control of the jaws and tongue, the accurate observation of the air movements, and the convenient use of intravenous injection are prevented. Experience has convinced me that this is an undesirable method for use in the surgical clinic and like the pulmotor should pass into innocuous desuetude.

For over twenty years we have used the following routine. If cessation of respiration is feared or occurs, the anesthetist affixes a delicate wisp of cotton by a bit of adhesive plaster or collodion to the tip of the patient's nose. This hangs in front of the patient's nose and mouth and is a positive indicator of spontaneous or induced air movements. The patient's arms are extended alongside his head. A large pad is placed in the abdominal wound to prevent the extrusion of intestines, and the abdomen and chest are covered by a sterile towel or sheet. If the cotton indicator remains motionless, the operator standing on the right side facing the patient's head, clasps his hands together over the manubrium of the patient, his elbows and forearm coapting the lateral thoracic walls. With pressure of the hands, forearms and elbows back, down and in, aided to some degree by the weight of his body, which is swung upon the patient's chest, the operator produces expiration, at the same time watching the patient's face and noting the effect

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of his pressure upon the cotton indicator. The effect may be aided by pressure from the hands of an assistant placed

as it enters and leaves the patient's chest. To forestall circulatory failure, it is wise for an assistant to promptly start an



FIG. 1. Artificial respiration by intermittent compression of anterior thoracic wall. Patient's arms extended alongside head. Operator's hands are clasped over patient's sternum, and expiration, proved by cotton indicator affixed to patient's nose, is produced by downward, backward and inward pressure with hands, forearms and elbows. Meanwhile epinephrinized saline, guided by reaction upon pulse, is being given.

under the operator's elbows. Inspiration, of course, results as the pressure is sharply released. The anesthetist maintains an open airway by keeping the mandible and tongue forward, notes the movements of the tidal air produced, watches the pupils and the carotid, temporal or radial pulse and is prepared to administer carbon dioxide oxygen, or other restorative.

Nothing should be given by inhalation, however, until the operator has proved that he can produce adequate movements of air to and from the patient's lungs. The cotton indicator is invaluable in showing the efficiency of the operator. For example, in a case in which a patient was kept alive for about five hours by the method, using relays of assistants and medical students, I found that certain men were unable without special training to move the tidal air. The anesthetist watching at the patient's head and maintaining an open airway by mouth gag or tongue forceps, should not only see the cotton move but also hear the rush of air

injection of epinephrinized saline solution into a convenient vein in the patient's arm or leg.

Compression methods for the production of artificial respiration, while usually very satisfactory, at times will fail. In certain patients with emphysema, a heavy barrel shaped chest, a pleural effusion or extensive disease of the lungs, it is not possible to produce artificial respiration by compression of the chest alone. The senile chest with calcified costal cartilages has limited compressibility. The same thing is occasionally true even in children. In a young child and also in a heavy chested athletic young man, I was unable to sufficiently move the tidal air, as shown by the indicator or by audible currents of air. In such a case what should be done?

It is probable that the Silvester method or the Marshall-Hall method will also be ineffective, so therefore, we immediately abandon all compressive methods, and use forced inspiration by mouth to mouth insufflation. The operator steps to the side

of the patient's head, compresses his nose with one hand and with the other makes pressure over his epigastrium to prevent

otomy opening. Mouth to mouth insufflation has displaced the more complicated methods of forced artificial respiration in



FIG. 2. If cotton indicator shows that sufficient air movement to and from chest does not occur from intermittent compression, mouth to mouth insufflation is promptly substituted. Patient's mouth, held open by gag, is covered by four layers of gauze, and nostrils and stomach are compressed as operator intermittently inflates lungs. During inflation chest can be seen to expand; during expiration rush of escaping air is heard.

distention of the stomach by air. The patient's mouth having been covered by two to four layers of gauze or a thin towel, the operator takes a deep inspiration, immediately applies his widely opened mouth over that of the patient and makes forcible exhalation. If properly performed the patient's chest will be observed to expand as the air is blown into his mouth and at the end of the insufflation, as the operator raised his head, a rush of air will be heard coming from the patient's lungs which is increased by an associated manual compression of the chest. For an adult patient, the mouth to mouth insufflation is safe, as the pressure in the patient's lungs cannot exceed or even equal that in the operator's thorax. In children, however, care should be taken that undue pressure is not produced, remembering the deaths which have followed the rupture of alveoli in infants or adults from the use of the pulmotor. In two cases, before we realized the effectiveness of simple mouth to mouth insufflation, we produced forced inspiration by intermittently blowing through a tube placed over a trache-

our clinic, when the simple compression of the chest has failed, and has saved at least four lives. But why not use oxygen or oxygen-carbon dioxide through the face piece of the anesthesia machine? Because it is not fool proof. In the desperate emergency there is no time to make sure that the machine is properly delivering only pure oxygen and carbon dioxide in the right proportions. I saw one patient die from time lost as the anesthetist insisted on proving how effective his apparatus was for purposes of resuscitation. Others may find as Stanley did, when it is too late to help the patient, that a nitrous oxide tank had been placed for that of oxygen. The operators' lungs are not subject to such error. They will deliver only oxygen and carbon dioxide. Usually it is necessary to use a mouth gag and occasionally hold the tongue forward and to the angle of the mouth by a forceps, tenaculum or thread during the insufflation. An alternative method of preventing the entrance of air into the stomach is to press the larynx back against the esophagus.

If tidal air is properly moved by the thoracic compression alone, the operator and his assistant may maintain the sterility

In respiratory failure and before the respirations have entirely ceased a powerful stimulus may be obtained by the inhalation

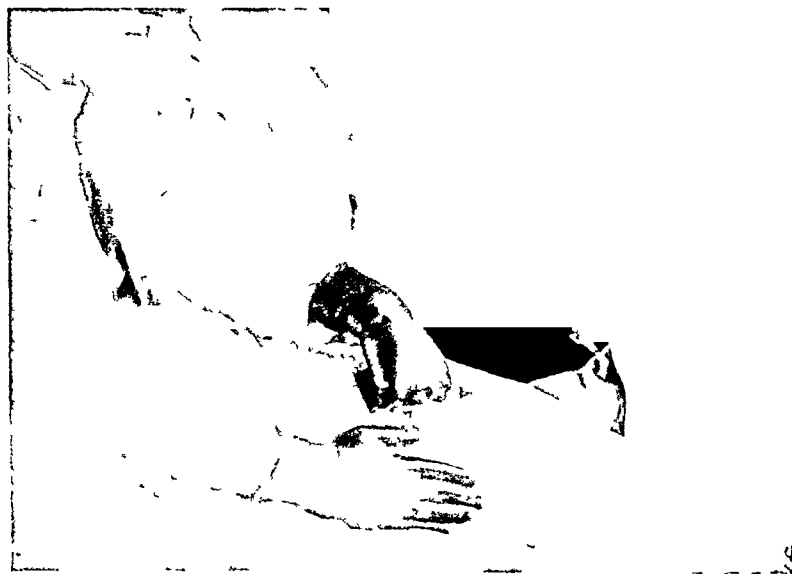


FIG. 3. If heart has stopped and does not respond to an intracardiac injection of epinephrine, index finger is carried through a 2 cm. incision in third left intercostal space and hooked about heart which is compressed and massaged against overlying chest wall. Sterile wet gauze wrapped about base of finger prevents entrance of air into thorax.

of gloves and gowns, being ready to immediately complete the operation or, should such prove necessary, to introduce the hand in the abdominal wound for cardiac massage. The respirations produced should not exceed a rate of fourteen to sixteen per minute.

Methods of artificial respiration are seriously handicapped by regurgitant vomiting. The gastric secretions may flood into the pharynx or mouth and the patient be drowned by his own fluids. I have seen one patient die from this cause. On the regurgitation of gastric liquids the head of the patient should be markedly lowered, and if large quantities of fluid well into the mouth, as occurs in ileus, a tracheotomy should quickly be done and the respirations conducted through the tracheal opening. Of course the danger of regurgitation may be reduced by gastric lavage before the anesthetic is given, but at times the fluids continue to well back from the duodenum and the lavage is insufficient.

of oxygen containing 10 per cent of carbon dioxide. Such inhalation should not prevent an early resort to artificial respiration when it is needed. In any case, the circulation should constantly be watched. The difficulties of resuscitation are enormously increased by circulatory failure and the patient will surely die if the heart absolutely stops for more than seven minutes. An early resort to intravascular infusion with epinephrinized saline insures against cardiac arrest, and an intravenous outfit should always be ready for instant use in every operating room. The smallest quantity of epinephrine solution that will produce the desired effect (it may be $\frac{1}{2}$ minim, it may be 100 minims of the 1:1000 solution) should be used. We start with 200 c.c. of saline solution containing 10 minims of the standard 1:1000 epinephrine solution. The instant the pulse responds, even though but a small fraction of the epinephrine has entered the vein, the flow is arrested to be resumed intermittently later as required. In this

way a prolonged effect may be produced. If there is no response the percentage of epinephrine in the saline is very rapidly increased until a response is evoked. An excess of epinephrine is harmful, putting at times an enormous strain upon the heart and vessels and being followed by corresponding secondary circulatory depression.

With absolute arrest of the heart, a direct local stimulus is usually necessary to carry the epinephrine into coronaries where it becomes effective. With the open abdomen subdiaphragmatic cardiac massage is easily produced. The operator should be careful not to have the left lobe of the liver interposed between the internal hand and the diaphragm. In about 20 cases of cardiac massage the subdiaphragmatic method was the only one that gave me an enduring effect. Occasionally, I have found it will fail where a transthoracic massage will stimulate the heart to action. It is not necessary to turn back a flap of the chest wall for transthoracic cardiac massage. A stab is made through the left third interspace 2 cm. from the sternum (to avoid the internal mammary artery) the finger introduced into the chest as the knife is withdrawn and curled about the left border of the heart, which is rhythmically compressed against the overlying chest wall by flexing the finger.

The intraventricular injection of epinephrine gives a violent stimulus to the heart that is very effective and has largely displaced cardiac massage. A 22 gauge needle 9 cm. long is entered at the left

border of the sternum in the third interspace, carried in and mesially until the resistance of the ventricular wall is past, aspirated to prove that the point of the needle is in the free ventricular cavity and the withdrawn blood reinjected with the 5 or 10 minims of epinephrine in the Luer syringe. These drastic procedures should rarely be necessary. During the period of dire emergency the subcutaneous injection of stimulants may divert the attendants from quicker and more effective measures. Therefore, we avoid them. Finally it may be noted, that the need of an intracardiac injection during an operation usually indicates that the patient has not been watched with sufficient care, or that the proper prophylactic measures were not instituted sufficiently early.

SUMMARY

1. The conventional methods of artificial respiration are not well adapted to operating room practice.
2. The operator should use no method of artificial respiration that does not cause adequate quantities of air to enter and leave the patient's chest. Artificial respiration is not a gesture, it is an effect.
3. Efforts at artificial respiration should be continued if necessary for many hours, or at least until the heart no longer responds to even the most powerful direct stimulus. The patient should be kept warm.
4. A time tested and effective plan for routine use is here given.



CLINICAL SIGNIFICANCE OF THE FORM & FUNCTIONS OF THE DORSAL ROOTS IN SPINAL ANESTHESIA*

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THE purpose of this paper is to correlate some of the known facts of the anatomy and physiology of one division of the sensory pathway so that one can formulate on the basis of these facts a working hypothesis which should explain some of the physiological disturbances produced by spinal anesthesia. The interpretations submitted here have been deduced from clinical experience only, not physiological experiment. This type of anesthesia does not lend itself readily to animal experimentation as there is the greatest divergence between the highly organized nervous system of man and that of the lower vertebrates.

Since spinal anesthesia is usually produced by the introduction of a neurotropic drug in the subarachnoid space, generally in the lower lumbar region; its local and immediate actions must necessarily be confined in this space which in this region is filled by the roots of the spinal nerves that go to make up the cauda equina. Therefore, if we wish to study the specific action of this neurotropic drug, it is essentially important that we should know very minutely the anatomy of the structures in the subarachnoid cavity. However, in my opinion, it is not necessary to discuss the anatomy of the cord or of the ventral nerve roots because we can explain all the physiological phenomena of spinal anesthesia by the action of the drug on the dorsal roots alone.

It is true that this view is not held by the majority of writers on this subject; Labat states that "the sensory and motor roots being apart from each other, the action is

greater on the motor fibers than when injecting the mixed nerve trunks, even by the endoneural method, outside the spine. Motor paralysis is the natural consequence of intraspinal block." This point of view is also held by that brilliant exponent of spinal anesthesia, Babcock. I shall attempt to show that this statement of Labat cannot be sustained on either pharmacological or physiological grounds.

The sensory neurone system is much more complex than is the motor neurone system. In its simplest form it consists of at least four neurones while the simpler motor neurone system is made up of only two, a lower and an upper neurone. To this complexity of the sensory system we can attribute its vulnerability to the action of all types of anesthetic drugs. Hitzig and Bernstein have established the fact that everywhere in the central nervous system the motor mechanism is particularly resistant to narcosis. Therefore, it is not surprising that local anesthetic drugs of the benzoyl group, of which novocaine is deservedly the most popular, affect almost exclusively the sensory elements of the nervous system. Independent experiments by Koch, Dixon and Santesson proved this many years ago. The pharmacotropic action of novocaine for sensory elements is so pronounced that its conduct may be likened to that of a vital stain, picking out sensory fibers and avoiding motor filaments. The selective affinity for certain nerve elements is a feature common to many other neurotropic drugs as exemplified by adrenalin, acetylcholine, nicotine, curare and so on. It would be reasonable to postu-

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late from the pharmacodynamic evidence of the elective affinity of the cocaine group for sensory nerve tissues that the brunt of the action of novocaine in the subarachnoid cavity would be on the dorsal roots. From this standpoint we are justified in assuming that the tendency of novocaine would be that of blocking the posterior nerve roots and permitting conduction through the anterior nerve roots.

This statement may still appear, on the surface, rather paradoxical, for it is known that spinal anesthesia does produce various degrees of so-called motor paralysis which is especially marked in the lower limbs. However, let us analyze this type of paralysis from the standpoint of the physiology of the afferent nervous system. We have learned from the physiologists how tremendously complicated muscular movement really is, and how, in order to coordinate these movements, there must be a constant stream of informative impulses flowing along the posterior roots to the portion of the brain which initiates the movement of locomotion. The significance of this important general principle that the essential basis of all purposeful and effective motor activity is to be found in accurate sensory information seems to have been overlooked by many authors on spinal anesthesia. The part played by afferent impressions in the coordination of muscular movement was emphasized several years ago by Starling. He was the first to point out that experimental section proximal to the ganglia of all the posterior nerve roots supplying a limb produces a functional, though not an actual, paralysis of the muscles of that limb. Furthermore, it has been shown that postural activity of muscles (muscle tone) depends primarily on the integrity of the posterior nerve roots. If these impulses from the corresponding muscles are not received, loss of tone results; the muscles become flabby and the limb can be placed in unnatural positions and excessive movement is permitted at the joints without producing discomfort. Obviously in Starling's experiment there devel-

ops anesthesia of the entire limb for all forms of sensation because the sensory impulses from the periphery are cut off from the spinal cord. This description of some of the results following experimental section of the posterior nerve roots is applicable to the picture produced by spinal anesthesia except that the latter procedure produces only a temporary section of these same fibers. It is apparent, therefore, that the presence of paralysis of the lower limbs in spinal anesthesia is not in any sense of the word indicative that the motor roots have been affected by the drug.

It is not essential in this paper to consider the form and function of the spinal cord because we have no tangible evidence that spinal anesthesia has any direct influence on this important structure. It may appear on casual examination that this form of anesthesia produces a physiological section of the cord. A careful neurological investigation will show, however, a radicular type of block.

In order to understand spinal anesthesia we must have a clear conception of the minute anatomy of the dorsal nerve roots proximal to the ganglia. I hope to show that a careful scrutiny of the histology of this region of the dorsal nerve roots will elucidate the selectivity of novocaine when introduced intrathecally. The accurate researches of Ranson have done much to clarify the anatomy of the dorsal nerve roots. In 1912, Ranson modified the Cajal silver technique in such a way as to produce a differential stain of non-myelinated fibers and applied to the method the term "pyridine silver technique." As a result of this procedure, he has been able to demonstrate the existence of a large number of non-myelinated fibers in the dorsal roots of spinal nerves. For many years the prevalent view has been that both the dorsal and ventral roots of the spinal nerves are made up exclusively of myelinated fibers. As to the function of the myelin sheath in medullated nerve fibers very little is known. Many speculations have been indulged in with regard to its

function but practically nothing that is certain can be said upon this point. It has been supposed by some to act as a sort of insulation preventing contact between neighboring axis cylinders and thus insuring better conduction. But against this view it may be urged that we have no proof that the non-medullated fibers do not conduct equally as well. There is, however, some evidence that this sheath plays an important part in the chemical process involved in the act of nervous conduction. Furthermore, the fibers which possess a medullary sheath are more resistant to defective blood supply and toxic agents. It is probable that the myelin sheath serves as a source of nutrition to the enclosed axis cylinder, which, in the greater part of its course is far removed from its trophic center, namely, the cell from which it is an outgrowth. This so-called trophic function of the myelin sheath has a certain basis in the fact that the myelin sheath is larger in those fibers that have the longest course, the size of the sheath in fact increasing with that of the axis cylinder. In describing the dorsal nerve roots, Ranson notes that the fibers that are not myelinated are very small and also have a relatively short course. This, surely, fits in with the idea of the probable trophic function of the myelin sheath.

Although Woollard states that Ranson's observations have not won general acceptance on either anatomical or physiological grounds, his work, however, has been confirmed by Ingvar and accepted by Hauptman. Ranson thinks that these non-myelinated fibers can only be shown by his modified stain and, therefore, most anatomists have failed to see them. Also there has naturally been reluctance to accept a radical change like this in fundamental ideas. However, the evidence which he presents is very convincing when viewed from the spinal anesthetic standpoint. He describes the intrathecal part of the dorsal roots in the following manner:

The central end of a dorsal root breaks up into many rootlets or filaments which enter the

spinal cord in linear order along the line of the posterior lateral sulcus. As it enters the cord each filament can be seen to separate into a larger medial and a much smaller lateral division. The fibers of the medial division are of relatively large caliber and run over the tip of the posterior column into the posterior funiculus. The fibers of the lateral division are fine and enter a small fascicle which lies along the apex of the posterior column, the fasciculus dorso-lateralis or tract of Lissauer. Very soon after their entrance into the cord each dorsal root fiber divides in the manner of a Y into a larger ascending and shorter descending branch.

He maintains that the fibers of the lateral division of the dorsal roots are all very fine and that the majority are non-myelinated. Those of the medial division, on the other hand, are practically all myelinated.

Having considered this conception of the morphology of the dorsal roots, it will now be advisable to discuss the variety of sensory impulses carried by these different types of nerve roots. In 1822 the French physiologist, Magendie, after a vast amount of research gave to the world his fundamental dictum that the dorsal roots of the spinal nerves carry all forms of sensation. In 1900, Sherrington classified the filaments of the dorsal roots from a functional point of view, into three broad groups. In this classification he designates those dorsal fibers carrying impulses from the viscera as interoceptive and subdivides the somatic afferent fibers into exteroceptive and proprioceptive groups. The exteroceptive fibers carry impulses from the surface of the body. These fibers, therefore, are actuated exclusively by external stimuli. The impulses produced in this way are carried by these special fibers to the spinal cord and then relayed to the cerebral cortex where they are interpreted as the sensation of heat, cold, pain and touch.

The proprioceptive fibers carry nerve impulses which on reaching the central nervous system give information concerning the tension of the muscles and the relative position of various parts of the body. For the most part, however, these impulses do not rise into consciousness but

serve for the subconscious control of muscular activity. There are, therefore, two main groups of afferent somatic impressions that eventually excite sensation, namely those that come from the skin and those that originate in the deeper or proprioceptive structures of the body. The much greater importance of the latter in determining the activity and reactions of the body must not be forgotten; a limb with cutaneous anesthesia may be quite a useful member but complete loss of all forms of deep sensations would make it worthless to the individual.

It may be noted here that the observations on which Head and his co-workers attempted to subdivide cutaneous sensations into protopathic and epicritic groups have no bearing on the problem of sensory dissociation in spinal block. Thus, all forms of touch, whether crude or precise, all forms of temperature whether extremes of heat and cold, or intermediate grades of temperature and all forms of pain are conveyed by exteroceptive fibers. These exteroceptive fibers having a very short course terminate in the dorsal horns around cells whose axones go to make up the spinothalamic fibers in the opposite ventrolateral column.

The coarse medullated fibers of the mesial division of the dorsal roots carry proprioceptive impulses. They ascend without interruption through the dorsal columns to the medulla oblongata.

We are now in a position to develop a coherent idea of the anatomy of sensation as applied to the central processes of the primary sensory neurones on their way to the posterior lateral sulcus of the spinal medulla. Ranson assumes that the small non-medullated fibers, previously described, carry exteroceptive impulses out of which the sensation of heat, cold, pain and some forms of touch are elaborated. His conclusions have been confirmed recently by Gasser, Bishop and Erlanger using the cathode ray oscillograph.

Physiological investigations by these observers have shown that the action

currents in the dorsal roots are very heterogenous, whereas in the ventral roots they are more or less homogenous. Analyses of these waves have shown that the dorsal roots are composed of at least four different types of fibers (alpha, beta, gamma, delta). The ventral roots are made up only of alpha fibers. These four components of the dorsal roots are associated with different functions as shown by their histological and physiological characteristics. Thus the alpha fibers have the largest cross section, the greatest velocity of nervous impulses, the lowest threshold to stimulation and the shortest absolute and relative refractory periods, whilst the beta, gamma and delta fibers have progressively smaller diameters, lower velocities, higher thresholds and larger refractory periods. This natural group of the velocities of impulse propagation in these different types of axones falls into accord with the observations of Lapique and his colleagues on the varying chronaxies of nerve trunks. Lovatt Evans has suggested that motor impulses to muscles, sensory impressions and afferent depressor impulses belong to the alpha class; the beta sensory impressions evoke respiratory reflexes and the gamma pressor reflexes. The delta fibers correspond to the fine non-medullated fibers of the dorsal roots which Ranson has been able to stain by his silver pyridine method. Since the four types of fibers have different morphological and functional characteristics, it would be safe to postulate that their behavior under the influence of novocaine would also differ.

Having considered in detail some of the known anatomical and physiological data of the areas affected by the intrathecal dose of novocaine we are now able to understand and interpret some of the clinical findings observed in routine spinal block. The physical and functional differences in the posterior root fibers afford a very practical explanation of the dissociation of sensation produced by spinal anesthesia. On a purely physical basis it would not be difficult to account for the exquisite

sensitivity of the exteroceptive fibers to very dilute solutions of novocaine because of the small size of the fibers and the absence of the insulating coat of myelin, whereas the larger and well insulated fibers of the proprioceptive group should offer greater resistance to the effect of very dilute solutions. This assumption can be verified readily by giving a small dose of novocaine intraspinally. For example, if 40 mg. of novocaine dissolved in 4 c.c. of distilled water be slowly introduced intrathecally at the level of the fourth lumbar interspace only the exteroceptive and interoceptive fibers below the level of the twelfth thoracic segment will be blocked. Within five minutes analgesia and thermoanesthesia will develop in the area supplied by these segments with no appreciable disturbance of deep sensibility and hence no paralysis or ataxia of the limbs, the tendon reflexes not being abolished. In this experiment the concentration of the drug is not sufficient to cut off all the afferent impulses and, therefore, we get the type of dissociated anesthesia as seen in a typical case of syringomyelia.

However, if 160 mg. of novocaine dissolved in 1 c.c. of distilled water be administered in the same manner a different condition will exist. Complete anesthesia and paralysis of the lower half of the body supervenes. There is a zone of analgesia and thermoanesthesia above the area of complete anesthesia. In this case we obtain a complete block in the region where the drug was first introduced and a partial block where dilution has occurred. In this way the relative safety of high spinal anesthesia can be explained. The cutting off of the exteroceptive and some of the interoceptive impulses does not break the reflex arc and hence no interruption of function of the affected segments. If the proprioceptive impulses are also blocked we get the usual effect of complete section of the posterior roots, viz., paralysis, ataxia, and anesthesia.

As a result of the tremendous increase in the use of spinal anesthesia in the past

five years, the literature, especially on this Continent, has been flooded with articles on this subject. Consequently, it is rather difficult for the novice in this field to differentiate between worthless and useful literature. Although the outstanding contributions of Babcock, Labat and Koster have not had much to do with this increase in popularity it is to them that the serious student of this subject must turn. While Koster is relatively a recent convert to this method he has, by his original laboratory experiments supported by a relatively large personal experience, done much to stimulate an interest in the physiological side of spinal block. His revision of some of the older functional conceptions has changed the aspect of this subject. Nevertheless, some of his conclusions are open to criticism.

Koster's explanation of the absence of serious cardiac and respiratory impairment in high spinal anesthesia is based upon the following assumption, namely, that the property of excitability of nerve fibers is more resistant to the action of the benzoyl group than the conductivity of these nerve fibers. Various workers have shown that where, by progressive action of a narcotic a stretch of nerve has just failed to conduct to the muscle an impulse generated at the central end of the nerve, strong stimuli applied within the narcotized area will still provoke a contraction especially if applied at the peripheral part of the narcotized stretch. This appears to support the view that conductivity of nerve fiber is more easily affected by anesthetic drugs than the excitability factor. However, Kato and Forbes, independently, have shown that this apparent difference between conductivity and excitability is dependent upon the fact that very strong stimuli can spread far along the nerve, sometimes 30 mm., so that in these experiments such a stimulus can often affect portions of the nerve outside the chamber. When mechanical stimuli are used instead of electrical ones, the response falls simultaneously to stimuli above the chamber and at all points within

it. It seems unlikely that any hypothesis would be sound based upon physiological experiments, the interpretation of which is so controversial. Therefore, Koster's statement, "that spinal anesthesia for surgery of the head, neck and thorax is relatively safe because it is possible to have anesthetic action to the point of interruption of sensory impulses in nerve fiber and yet be far from a complete depression of excitability of nerve cell" is not supported by the very experimental work from which he draws his analogy. In my opinion high spinal anesthesia owes its safety to a low introduction of a concentrated solution of novocaine which, when it reaches the upper nerve roots becomes so dilute that it is only able to affect the small non-myelinated exteroceptive and interoceptive fibers of the upper dorsal roots. Personal observations from a number of high spinals have demonstrated that in the head, neck and thorax the sensory loss is of the dissociated type as found in syringomyelia, that is, pain and thermic sense are lost, deep sensibility is retained while in the abdomen, pelvis and lower extremities there is a complete loss of all forms of sensation. There is in high spinal anesthesia an interruption of the exteroceptive and interoceptive impulses in the upper third of the body while in the lower two-thirds there is an interruption of the proprioceptive as well as the exteroceptive and interoceptive impulses. In other words there is analgesia and thermoanesthesia in the upper third and complete anesthesia and muscular relaxation in the lower two-thirds of the body.

Let us now consider a more difficult part of the subject, namely the arrangement of the afferent neurones of the involuntary nervous system. The knowledge of this part of the involuntary nervous system is still very meager. Anatomical studies show that the visceral afferent fibers are chiefly medullated and of varying size with an admixture of a considerable number of non-myelinated fibers, all of which have their cell stations in the dorsal root ganglia.

From the ganglia central processes are sent into the spinal gray matter.

In describing the physiology of spinal block most authors ignore the afferent side of the autonomic system stressing only the supposed effect of the drug upon the white rami communicantes. It is interesting to note here that anatomically the white rami are not strictly in the subarachnoid space, although the fibers that go to make up part of the white rami are, but these fibers have not been given any special anatomical designation, being known only as preganglionic efferent fibers. Hence it would be more precise not to use the term white rami in describing the effect of novocaine on the sympathetic nervous system. I feel that we can explain all the sympathetic effects of spinal block by the theory that the drug acts only on the afferent side of the autonomic nervous system. There is reason to believe that under normal conditions the autonomic fibers are always excited reflexly although normally we receive no conscious sensations from most of our viscera. The bladder and the rectum are exceptions to this rule because at various intervals we receive information concerning the state of tension in these organs. The afferent impulses from the viscera are chiefly expended in reflexly affecting the activity of various involuntary structures such as the blood vessels, glands and smooth muscle fibers. If these afferent impulses are cut off it must follow that the sympathetic system would be paralyzed. Anatomically, it is known that most of these afferent fibers are non-medullated while those of the efferent side of the autonomic group, namely, the preganglionic fibers that go to make up the white rami are all medullated. It is not difficult to assume that novocaine attacks by preference these non-medullated fibers and in this way breaks the reflex arc of the sympathetic nervous system. It would be beyond the scope of this paper to discuss in detail the physiological derangements produced by interfering with the sympathetic reflex arc. This temporary disorganization of the autonomic nervous

system is one of the disconcerting features of spinal block. The removal of sympathetic control, as Cannon has shown in his sympathectomized animal experiments, certainly places the circulatory and respiratory mechanisms at a disadvantage. We can, therefore, say that the modern trend of the exhibition of sympathomimetic drugs such as adrenalin and ephedrine, in an attempt to reinforce the depressed sympathoadrenalin system, is based probably upon sound physiological principles.

CONCLUSIONS

First, that all the disturbances produced in this form of anesthesia can be explained by the effect of the drug on the afferent side of the nervous system.

Second, that there is anatomical, physiological, pharmacological and clinical evidence in support of this view.

Third, that spinal anesthesia is a pure, posterior, radicular block of variable intensity.

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PRESENT STATUS OF MANAGEMENT OF CARCINOMA OF THE BREAST*

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OF the many problems confronting the physician of today, none presents a more gloomy outlook than the subject of cancer. Over 100,000 people die of cancer every year in the continental United States. Cancer of the breast is responsible for 10,000 of these deaths. This unduly large percentage might be averted by timely treatment.

In the present state of our knowledge the best method of treatment is dependent upon early diagnosis of cancer. Our objective is to get the disease while it is still local and susceptible of complete removal.

Much information has been circulated among the laity which has resulted in getting patients to consult their physicians earlier.

The physician should become acquainted with the early signs and symptoms of the disease. The old cases with fixation of the breast, large axillary glands, ulceration, and cachexia call for the services of the undertaker rather than the surgeon.

In considering a breast lesion it is important to remember that (1) cancer is the most common cause of a definite lump in the breast of a non-lactating woman over twenty-five years of age; and that (2) any such lump should be regarded as cancer until proved otherwise.

The more certain you are that the condition is cancer the more advanced is the disease.

Cancer should be suspected when there is: (1) any lump in or near the breast or arm-pit; (2) any discharge, whether bloody or not, from the nipple; (3) any acquired distortion or inversion of the nipple; (4) any appreciable enlargement or diminution

in the size of the breast; (5) any abrasion or ulceration near the nipple.

The earliest clinical evidence of cancer of the breast is obtained by palpation, and consists in the finding of a definite, irregular, hard, non-sensitive lump that cannot be moved independently of the breast and that shades away gradually into the surrounding breast tissue without any clearly defined line between tumor and breast tissue. Oftentimes in moving the skin over the tumor some dimpling may be observed. Adenomatous and cystic lesions are sharply circumscribed and are freely movable in the breast tissue. A small percentage of these benign lesions tend to become malignant. They may be left alone before the age of twenty-five, but should all be removed thereafter by simple excision of the tumor.

Multiple masses in one or both breasts are rather characteristic of chronic cystic mastitis. This condition may develop malignant changes in some of the affected areas, so the best treatment is by excision of the entire breast.

Enlarged axillary lymph nodes may be present in benign breast lesions and may not be demonstrable before operation in many cases of late cancer, so their presence or absence is not a vital sign in differentiating a benign from a malignant lesion. However, enlarged axillary nodes under the edge of the pectoralis major muscle should cause a diligent search for the presence of cancer of the breast, unless there is an obvious pyogenic infection.

A small percentage of breast cancers are accompanied by a bloody discharge from the nipple, and it is usually due to a pri-

* Submitted for publication September 17, 1931.

mary papillary epithelioma of a duct or to benign intracystic papilloma. The latter lesion has a tendency to become malignant, so both should be subjected to early operation. Bloody discharge may be rarely encountered in other benign lesions not requiring operation, but in doubtful cases exploratory incision should be done.

Eczematous involvement of the nipple or areola may bring the patient to the physician. The pathology of Paget's disease of the breast is now thoroughly understood. It is a carcinoma beginning in the milk ducts and extending to the skin around the nipple.¹ The eczema is secondary to the carcinoma, and not *vice versa*. Paget's disease of the breast must be differentiated from simple eczema. Simple eczema is not of as long standing and disappears under proper treatment. True Paget's disease of the breast is treated like any other carcinoma of the breast, that is, by radical operation. If there is any doubt as to the diagnosis an immediate biopsy should be done.

Any inequality in the size of the breast due to cancer will be accompanied by definite evidence of cancer. However, inequality in the size of the breasts may be present in the absence of cancer.

The earlier the lesion and therefore the more uncertain the diagnosis the better is the prospect of cure.

PROGNOSIS

We should not speak of cure in referring to cancer cases. We may speak of arrests only, as recurrences may occur at any time. I only recently learned of a woman who died of recurrences and metastases seventeen years after a radical operation.

The average duration of life of patients suffering from all types of unoperated cancer of the breast is from 3.2 years to 4 years after discovery of the tumor. This average includes patients of all ages.²

Daland³ of Massachusetts General Hospital says that about 22 per cent of all patients having untreated cases of car-

cinoma of the breast are alive at the end of five years.

Reports of arrests of less than five years' duration are of no value for statistical purposes as untreated cases have an average duration of life of three to five years.

The average duration of life after a radical operation is about five years. There is a gain of about one year between operated and unoperated cases.

A radical breast operation done in the presence of contraindications such as fixation of the tumor to the chest wall, metastases, fixation of axillary nodes, involvement of supraclavicular nodes, or edema of the arm, shortens the life of the patient. Such patients live longer without any operation, and a simple mastectomy gives a longer lease of life than a radical operation.

Analysis of statistics of results in breast cancer cases is very difficult. Most men simply give their average results in all cases. The presence or absence of axillary nodes, the type of carcinoma, and the use of radiation methods preoperatively or postoperatively, all have a bearing on the outcome. All these factors should be included in a statistical study of breast cancer if the study is to be of real value.

Bunts⁴ reports 24.1 per cent of five-year cures, 9.5 per cent of ten-year cures, and 4.1 per cent of fifteen-year cures, of 867 traced cases; 20.1 per cent five-year cures in cases with axillary glands involved; 35.4 per cent five-year cures in cases with axillary glands not involved.

A recently published Leeds Hospital report⁵ shows that 90 per cent of patients with breast cancer operated on before the lymph nodes were involved lived at least ten years after the operation.

The degree of malignancy is as important in determining the prognosis as is the presence or absence of axillary lymph nodes. Greenough,⁶ in a recent study of breast cases, has shown that a low degree of malignancy with involved lymph nodes is compatible with a longer lease on life

than a high degree of malignancy with uninvolved lymph nodes.

Broders,⁷ Sistrunk and McCarthy⁸ have made important contributions to this subject in showing how the degree of cellular differentiation, hyalinization, and fibrosis, are the greatest factors in determining the prognosis in these cases.

Gottesman² has recently advocated doing a biopsy at the time of operation to determine the degree of malignancy. If a high degree of malignancy is found he advises preoperative radiation to convert the high degree of malignancy into one of lesser degree.

An average of the statistics of results in cancer of the breast cases of 32 surgeons and clinics compiled from the literature by Portman⁹ gives 28.8 per cent five-year cures, the highest being 52.1 per cent five-year cures by Watson-Cheyne; the lowest, 15.9 per cent five-year cures by Rahm. The Cleveland Clinic Series shows 23.1 per cent five-year cures with surgery alone, and 35.8 per cent five-year cures with surgery and postoperative x-ray treatment.

Dr. A. C. Scott, Sr. of Temple, Texas, reports 72.7 per cent five-year cures in 11 cases; 2 out of 5 patients, or 40 per cent of cases with axillary nodes involved, were living at the end of five years; 100 per cent (6 cases) without axillary nodes involved were living at the end of five years. Dr. Scott does the radical operation using the electric cautery for incision and block dissection. He has done over 700 cautery breast operations.

Oliver¹⁰ reports results in 88 cases; 46 radical and 10 palliative operations were performed. Only a few patients were found living at the end of three years. These were ward cases at Cook County Hospital of Chicago. He attributes the poor results to the advanced stage of the disease and to the poor general resistance of these patients on entrance to the hospital.

Bevan¹¹ says that 75 or 80 per cent of breast cancer cases can be permanently cured if the disease is limited to the breast, whereas, if at operation the axillary glands

are found involved, the percentage of permanent cures drops to less than 10 per cent. Most cases come to the surgeon at a time when axillary glands are already involved. He says that we are curing 30 to 35 per cent of cancer of the breast cases.

Carcinoma of the breast in the young, during pregnancy, and the acute inflammatory type of carcinoma, all offer a very poor prognosis.

TREATMENT

Operable cases of carcinoma of the breast require the radical operation. This consists of removal of the entire breast and overlying skin, both pectoral muscles, and the axillary fat and lymph glands. The modern operation as devised by Halsted and by Meyer is the method of choice. This operation is done by cleaning out the axilla first, and removing the axillary contents, pectoral muscles and breast in one mass.

In some late cases a simple mastectomy is done as a palliative measure.

The modern radical breast operation is performed without much loss of blood, and without much shock. By opening the axilla first the blood vessels are secured early in the operation. Also, by this method we are less apt to milk lymph which contains cancer cells into the wound, or in aberrant directions through the lymphatics.

There is some evidence that postoperative irradiation is of value in carcinoma of the breast.

Trout and Peterson¹² of Roanoke, Va., received replies to a questionnaire sent to 149 surgeons and 199 radiologists; 89 per cent of the surgeons and 91 per cent of the radiologists believe that postoperative irradiation is beneficial as an adjunct to surgical treatment of carcinoma of the breast.

Preoperative Irradiation: There is some question as to the advisability of preoperative irradiation. Severe reactions sometimes occur and may occasionally favor metastases. Also, if operation is deferred a month or two to allow the full effect of

the irradiation to be exerted, there is additional time for metastases to occur.

Pancoast¹³ says that he had a rather unhappy experience with a group of cases irradiated preoperatively. Most of them recurred rather rapidly even with postoperative treatment. He further states that he is uncertain about the whole procedure and is waiting for more evidence.

Pancoast thinks that postoperative irradiation should be given as it cannot do any harm, and may do good. He believes that the patient should be allowed to fully recover from the effects of the surgical procedure before receiving postoperative irradiation. A month or two after operation a thorough series of treatments is given if no involved glands were found in the axilla, if they were found a second series of treatments is given later. Cases with higher degrees of malignancy had best be given more than one series whether glands are present or not.

In the present state of our knowledge routine postoperative irradiation treatment should be given in cancer of the breast cases.

In properly selected inoperable and recurrent cases considerable comfort may be obtained by irradiation. This is, of course, merely palliative treatment.

Irradiation is in no sense a substitute for surgery. Early removal while still a local disease is the best that modern treatment has to offer. This, followed by routine postoperative irradiation, seems to offer the best results. Pancoast mentions the case of a woman who came to him for treatment of a small lump in the breast of six months' duration. She had refused to be operated on. The growth disappeared after six months' treatment. Over a year later multiple bone metastases were found. Operation at the proper time might have prevented the spread of the disease.

I do not believe the operation should be any less thorough in operable cases because we have irradiation to fall back upon.

While discussing Dr. Bevan's paper¹⁴ which was read before the Section on

Surgery of The American Medical Association on June 27, 1930, Dr. Jacob H. Vastine of Philadelphia stated that his five-year cures in cancer of the breast cases are 87 per cent. There were 55 per cent five-year cures in cases with microscopically proved axillary metastases. These patients were operated on radically and this was followed immediately by postoperative irradiation within three weeks after operation.

We cannot rely on statistics alone in forming our ideas as to the value of the methods used in treating carcinoma of the breast.

The statistics that are needed are those compiled from the best men covering a large number of cases treated by surgery alone, by preoperative or postoperative irradiation, and by both combined. One group of statistics should cover strictly operable cases, and there should be further modifications of groups to include cases with axillary gland involvement and possibly other features. Also, each pathologic or prognostic group of breast cancers should have its own statistical tables. This is an enormous undertaking, but until it is accomplished, there should be less controversy over the unknown.¹³

SUMMARY

1. Early diagnosis is the keynote to successful treatment.
2. Arrests of less than five years' duration have no statistical value.
3. It is possible to cure 75 to 80 per cent of cases if they are treated while the disease is localized to the breast; when the axillary glands are involved less than 10 per cent of the patients survive five years (Bevan).
4. The radical operation and postoperative irradiation are the best treatment for operable cases.
5. There is need for more uniform and comprehensive statistics.

[For References see p. 248.]

PRIMARY DUPLEX LIVER CARCINOMA*

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PRI-MARY carcinoma is apparently quite a rare occurrence and of but slight practical importance. Clinically and grossly, the diagnosis cannot be made if there is also a carcinomatous involvement present in the stomach or some other organ in which primary malignancy is a more usual occurrence. Microscopically, however, it can always be made regardless of the presence of other malignancies, if the structure of the liver neoplasm shows the characteristic features of the hepatic tumor.

The case reported in this paper deserves notice on account of some unusual features both in the gross and microscopical appearance of the liver neoplasm.

CASE REPORT

S. G., male, sixty-four years of age, was admitted to the hospital on January 1, 1931 on the service of Dr. Henry Lerner, complaining of indefinite pains in the upper portion of the abdomen. These pains had been present since August 2, 1930, when he suddenly felt weak and faint and thought that he was going to die. At that time he had no dyspnea or pain but felt "as if all his strength was oozing out of his body." Subsequently he had vague dull pains in the upper portion of the right side of the abdomen. These pains had no relationship to his meals, sometimes travelled up to his right shoulder and finally became continuous and more intense. At no time was there any melena, vomiting, cough, precordial pain, or diarrhea. His appetite was good but he had lost 10 pounds during the month previous to admission. The family history and past personal history were entirely negative.

Physical examination revealed a well developed white male adult in the early sixties, appearing chronically ill. Scalp presented no lesions. Eyes reacted to light and accommoda-

tion, pupils were equal and regular. There was a slight icteric tinge to the sclerae. Nasal passages were normal. Teeth were somewhat carious; pharynx was clear. No palpable glands were present in the neck. Thyroid was not palpable and no abnormal pulsations were present.

Chest was emphysematous (barrel chest). There was equal expansion on both sides with somewhat increased resonance throughout. No râles were heard. Heart was not enlarged; impulses were distant but regular and no murmurs were heard. Blood pressure was 118/70; pulse 70 per minute; respirations 18 per minute; temperature 99°F. The abdomen presented tenderness over the right upper quadrant. The liver was palpable and its dullness extended downward to almost the level of the umbilicus. The liver edge was quite hard, tender and slightly irregular. No other palpable masses or points of tenderness were present in the abdomen. The Murphy signs were negative. There were bilateral inguinal herniae present. Rectal examination showed a small, moderately hard, but not tender prostate. The extremities presented slight edema about the ankles. The reflexes were normal. His weight was 126 pounds.

Laboratory reports were: Wassermann and Kahn tests were negative. Blood chemistry showed urea nitrogen 9.8; creatinin 1.4; glucose 62 mg. per 100 c.c. of blood. Van den Berg direct and indirect were positive. Sugar tolerance showed 77 mg. on the fasting stomach; 98 mg. one-half hour after the sugar was given; 139 mg. one and one-half hours later; and 118 mg. three hours later.

Urine examination showed 1.018 specific gravity; faint trace of albumin; no sugar; slight trace of bile; and microscopically there were a few white blood cells.

Hemoglobin 90 per cent; red blood cells 4,080,000; white blood cells 10,600 with polymorphonuclears 77 per cent; lymphocytes 20 per cent; monocytes 2 per cent; eosinophiles

* From the Koster Clinic Crown Heights Hospital.
Submitted for publication April 1, 1932.

1 per cent; bleeding time three and one-half minutes; coagulation time four minutes.

Fragility test was normal.

until February 15, 1931, when he died suddenly of pulmonary embolism.

A consent for wound inspection only was

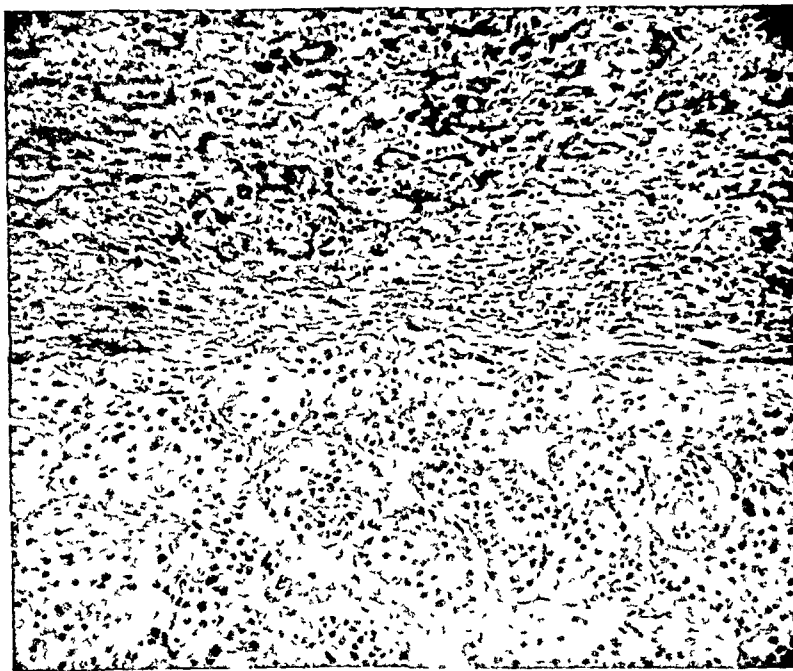


FIG. 1. Hepatocellular carcinoma tissue with wide blood spaces separated from adjacent tubular adenocarcinoma by a strand of fibrous tissue.

The blood counts were repeated three times and all were practically the same.

The gastric analysis was completely normal.

X-ray of the gastrointestinal tract revealed no abnormalities.

The medical service made a diagnosis of liver carcinoma secondary to some small focus in the gastrointestinal tract.

On February 10, 1931, the surgical division, concurring in the diagnosis of a liver carcinoma, and suggesting the possibility of its primary origin, advised a laparotomy for exploration.

On February 11, 1931, under spinal anesthesia an exploration was made. On opening the abdomen a moderate amount of ascites was found. The liver was markedly enlarged, hobnailed and studded with white and brown nodules varying in size from a pin-head to a pea. A complete exploration of the entire abdominal viscera did not reveal any other focus. A wedge-shaped portion of the liver was excised for biopsy and the cut edges sutured together. The abdomen was closed in layers.

The day following the operation the patient suddenly went into shock but responded well to treatment. His condition remained satisfactory

given. All the abdominal viscera were inspected minutely. No involvement of any organ was found with the exception of the liver. The heart showed a moderate amount of myocarditis with an embolus present in the pulmonary artery and with other smaller emboli in its branches in the lungs.

Pieces of the liver containing these white and yellowish-brown nodules were removed for histological examination.

The yellowish-brown nodules present on the portions of liver removed for study became green in color after formaldehyde fixation. Microscopically sections of these nodules showed a typical hepatocellular carcinoma. The cells were in the characteristic trabecular arrangement and the trabeculi were separated by the wide blood sinuses, lined with cells comparable to the Kupffer cells of the liver. The trabeculi consisted of cells very similar to liver cells and in some places were quite regular in size and shape. In these latter places the main difference between ordinary liver tissue and this tumor was the large size of the tumor trabeculi. In other places, however, conspicuous irregularities of the nuclei in both

size and shape could be seen. The regressive changes of the tumor tissue included fatty and hyaline degeneration of the cells. Extensive

connective tissue in which, occasionally, distended bile ducts were seen. The adjacent liver tissue quite frequently showed intra-

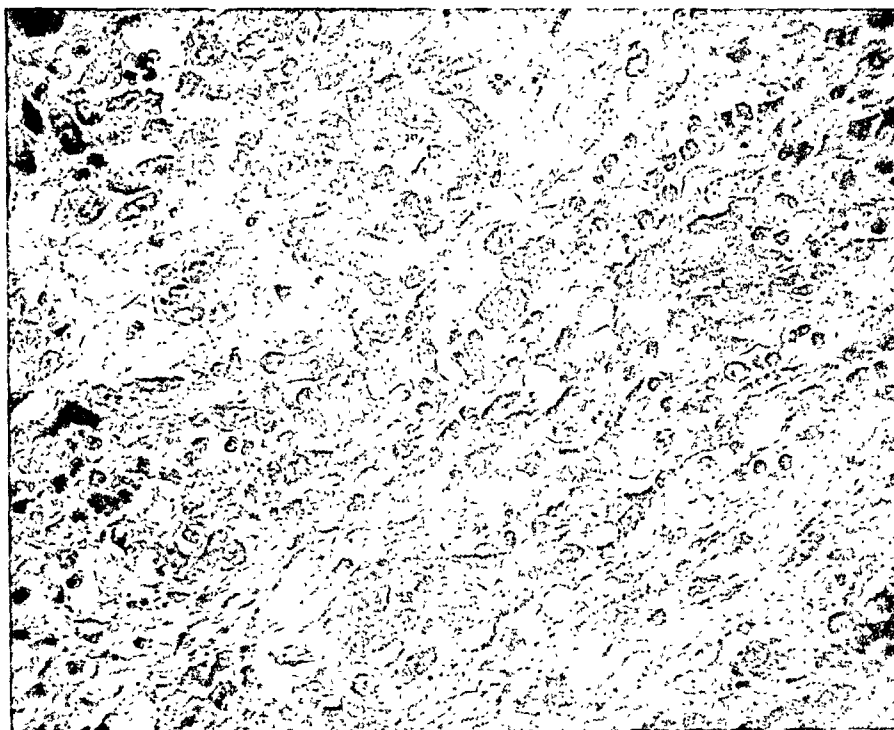


FIG. 2



FIG. 3

FIG. 2. Fibrotic area of tubular adenocarcinoma with mostly solid tumor cell groups and polymorphonuclears.

FIG. 3. Typical part of tubular adenocarcinoma.

areas of necrosis were also present. The nodules of the tumor tissue were surrounded by fibrous

capillary invasion by tumor tissue which grew and pushed the adjacent tissue aside. The

latter was flattened out in concentric layers. Tumor tissue also invaded some of the larger veins forming tumor thrombi which very often

The multicentric origin of the tumor was clearly seen in areas directly not invaded by tumor tissue in which the liver cells showed

FIG. 4

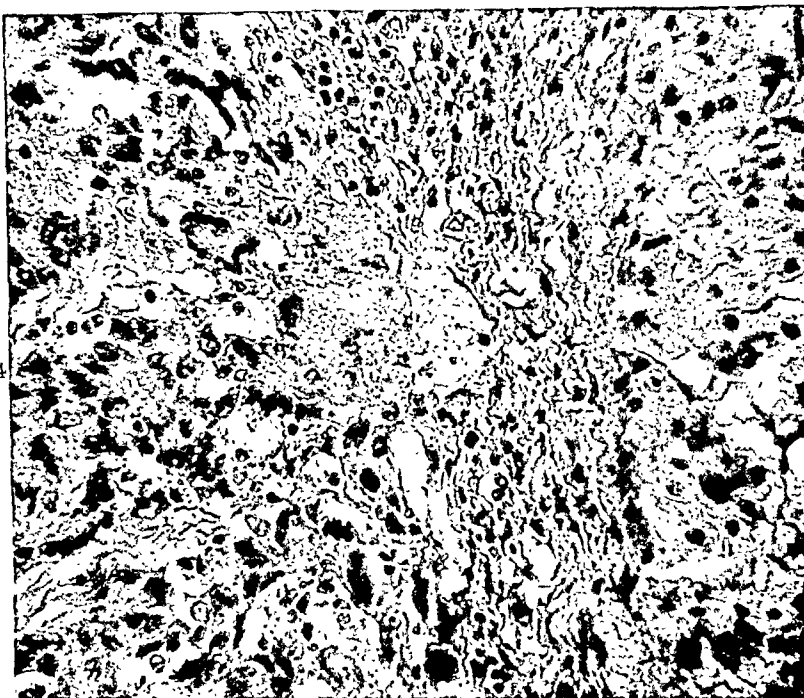


FIG. 5

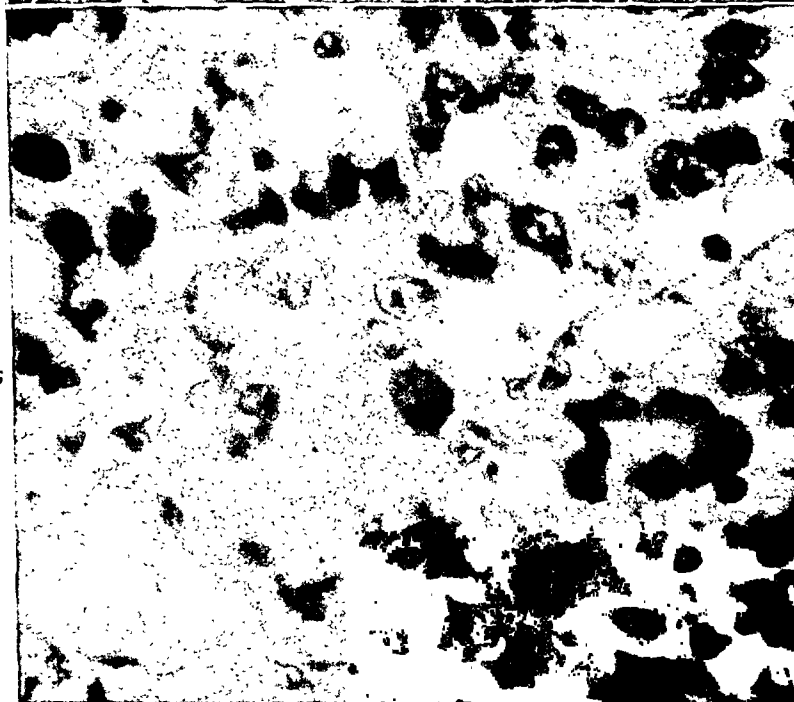


FIG. 4. Both tumor types separated by fibrous tissue. There are intermediary stages in adenocarcinomatous tissue with intracellular pigment.

FIG. 5. High power magnification of previous field (Fig. 4).

appeared completely necrotized or mixed with ordinary thrombus material.

striking evidence of anaplasia with gigantic and bizarrely formed nuclei. There was no

doubt that these peculiar cells were real liver cells and not metastases of the tumor tissue. Architecturally they fitted in like the regular pattern of the trabecular liver structure. Moreover, they were earmarked as liver cells because they contained the same yellowish-brown pigment which was present in the adjacent perfectly normal liver cells.

The stroma of the liver showed a quite noticeable increase of connective tissue particularly in the periportal fields similar to that seen in Laennec's cirrhosis.

The whitish nodules were of an altogether different structure. There was no trabecular structure visible nor any blood sinuses like those already described. The tumor tissue consisted of a fairly dense tubular parenchyma separated by more or less abundant fibrillar connective tissue with quite a good deal of lymphocytic and leucocytic infiltration. The tubular structures were quite regular in places and simulated the well known pseudo-bile ducts found in liver cirrhosis. The nuclei were round or oval in shape and fairly regular in places. In the main, however, they were very polymorphous and occasionally grouped together in giant cell formation. The tubular character was not uniformly distinct; in some places the lumen was absent, and thin arborescent trabeculi of two cell widths replaced the tubular structures.

The tubular type of neoplasm and the typical hepatocellular type were very often very close together. Sometimes a narrow zone consisting of some surviving liver tissue separated the two neoplastic tissues. In such places encroachment from both could be seen. Quite frequently only a thin wall of fibrous connective tissue separated the two different neoplastic tissues.

While the appearance of the tubular tumor tissue was distinct from the ordinary hepatocellular tumor tissue, there were places in which the change could be observed which made the two different types of tumor cells somewhat comparable. The cell body of most of the cells in the tubular type of tissue was small and the scanty cytoplasm stained a pale bluish-purple color. There were places however, where the cytoplasm took on a more pinkish color similar to that of the hepatocellular tumor cells. Moreover in places there was a peculiar enlargement of the cell body together with a loss of the tubular lumen. Thus large, almost syncytial cell groups were formed. The cytoplasm of these peculiar structures which

were only found far in between the tissues contained some of the yellowish pigment which was present in most of the surviving liver cells.

The description of the two different types of neoplastic tissue indicated that we were dealing with a duplex process of malignancy in one organ. The product of one process was a typical hepatocellular carcinoma; that of the other was a tubular adenocarcinoma which is much more common and, as a rule, interpreted as the product of bile duct epithelium and classified as cholangiocellular carcinoma.

It appears, however, that in this case the tubular adenocarcinoma did not take its origin from the bile duct epithelium but represented the product of liver cells. The presence of pigment in some of the tumor cells and the occasionally observed transitional forms between the two neoplastic cell types were strongly suggestive of such histogenesis.

It seems probable as pointed out previously by Goldzieher¹ that there is an intermediary stage between such tubular neoplastic tissue and the liver cells. This stage is represented by the so-called pseudo-bile duct which develops in cirrhotic processes of the liver from liver cells and may give rise to neoplastic tissue morphologically identical with cholangiocellular tumors. Yet a reversion to the original liver cell type remains possible. The fact that some of the pseudo-bile ducts retain the yellow pigment explains how such pigment can be found in tumor tissue of such origin.

The interesting feature of this case is the indiscriminate mixture of the two morphologically different neoplastic types in one liver. The only other case on record to our knowledge is the one reported by Goldzieher² in 1928. Yet in his case the bulk of the tumor tissue was purely hepatocellular and only one nodule was of the tubular adenocarcinomatous type. It is noteworthy that his one nodule was quite different in its gross appearance from the other tumor nodules. It was whitish in color and firmer than the other nodules. This coincides with our own observations.

¹ Goldzieher, M. A., and Von Bokay. *Virchows Arch. f. path. Anat. u. Physiol.*, 203: 75, 1911.

² Goldzieher, M. A. *Virchows Arch.* 267: 326, 1928.

CALCIUM TREATMENT OF PAIN IN CANCER*

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THE pain associated with cancer is one of the most disturbing and annoying symptoms which the physician is called upon to treat. Its terrifying constancy, and hopelessness of relief is well expressed in the following little poem from "The Blind Pursuer" by Ada Alden.

Through the faint day, and even in his dreams,
The pain pursues him edged and merciless,
Or just a blunt distress
All night the tortured, crying mysteries—
Bones, muscles, nerves, whose names he does
not know—
Are thrusting out their masked identities;
Battering and breaking down the fast-shut
door,
Beyond whose silence swings the radiant sign
That pain shall be no more.

How vividly do these few lines express the constant distress of a cancer patient! Any drug or method which will relieve this distress and pain will be of inestimable benefit.

It consequently has been extremely gratifying to the writer to note the effective and surprising results which, in certain cases, calcium has had in reducing and, in some instances, completely alleviating the pain of those suffering with inoperable cancer. The patient's existence becomes more bearable, the mental state improves, and the fight against the disease is once more resumed. The growth of the cancer itself is frequently retarded and may be totally controlled. Even though these latter results are obtained only in a restricted number of cases, calcium still merits a high place in the therapy of cancer if it only relieves pain and renders the use of narcotics unnecessary. This, in itself, if true, is a most important advance in the treatment of

cancer. If, by using calcium, narcotics can be discontinued, the evil effect of their use as expressed in terms of lassitude, lack of appetite, retarded activities of the tissues of the body and generalized depression are avoided. The patient becomes active and has a healthy appearance, with high color, a good appetite; and a feeling of well-being replaces the usual depressed attitude. I have noted this beneficial reaction almost constantly and have seen it persist up to the death of the patient.

In previous communications,¹ the writer has discussed the effect of calcium in malignant tumors, and further observation and study gives conclusive evidence of the beneficial effect of this therapy. Especially is calcium to be relied upon for the relief or reduction of pain. By its use the last days of a cancer patient are made more comfortable.

The patients whose histories are cited and who were treated with calcium, all suffered from incurable cancer, and the pain which they had, and which is almost universally associated with this disease, was lessened or entirely relieved. This relief with but a few exceptions, which will be noted, was the result of the administration of calcium. At first calcium was given in the form of the chloride and administered intravenously; later the gluconate was given intravenously for those cases in

¹ Review of the medical treatment of cancer. *Western Med. Times*, Feb. 1928.

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Non-surgical treatment of cancer, *Trans. Am. Therapeutic Soc.*, p. 73, May 14-16, 1927.

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Treatment of pain in cancer. *Med. J. & Rec.*, 130: 614, Dec. 4, 1929.

* Submitted for publication April 13, 1932.

which a rapid reaction was desired; intramuscularly if immediate results were not so urgent.

In addition to the administration of calcium, intravenously and intramuscularly (the action of which is more or less evanescent), it was also necessary to provide a constant source of calcium supply. This was best accomplished by giving large doses of calcium by mouth so that on absorption from the intestinal tract, the body fluids constantly were over saturated; to induce this condition the patient was given at least 2.0 gm. of calcium gluconate orally, three times a day. In order to further stimulate the activity of the calcium, cod-liver, alone, $\frac{1}{2}$ ounce three times a day, or codliver oil with viosterol was also supplied the patient, the dose being one dram, three times a day. A peculiar antagonism to cod-liver oil was present in several of our patients who were taking calcium. A few days after beginning, per os, the ingestion of 1 ounce of cod-liver oil (Waterbury's) three times a day, they complained of being sick, and stated that they were "made very sick by the oil, so that they developed a strong aversion to it." Those who were not taking the calcium did not notice such an aversion.

In connection with the administration of cod-liver oil, it is well to recall that the only other foods in which vitamin D is present, in amounts sufficient to be of therapeutic value, are egg yolk and cream. These may be placed in quantity in the diet. To further mobilize the calcium in the system, parathyroid extract was given to a few patients but, for reasons which were considered significant, was later discontinued.

At first, because of the large doses of calcium, it was expected that disagreeable effects of hypercalcemia might result; no pernicious reactions were noted (though the blood calcium in some cases temporarily mounted to 20 mg. per 100 c.c.). Minor symptoms, as loss of appetite or a slight malaise, did occur. When these developed the calcium which had been given per os was immediately discontinued.

In cancer therapy it is also absolutely necessary that the patient's appetite be preserved in order that his weight and general well-being be maintained at a high level. In my experience, increase in weight in a cancer patient is usually a sign of good portent, while a loss of weight seems to be an indication of increased activity of the neoplasm, or at least a loss of resistance by the patient. In every case it is of evil significance.

Without discussing the manner in which calcium influences the pain which is usually associated with the terminal stages of a cancer, I shall report the histories of several patients suffering from cancer, in whom pain was an insistent factor, and in whom there was a definite relationship between the administration of calcium and the cessation of the pain. In some of these cases it will be noted that the administration of calcium was temporarily discontinued, with return of the pain, which promptly disappeared again on the resumption of the calcium treatment.

Most of the reports date back two or three years. Our recent cancer patients have little or no pain; they are all treated with calcium with entire relief except in those who are in the terminal stage of cancer and in whom the original growth or metastases produce pressure on terminal nerve filaments, thus causing pain. Pressure pain is not easy to relieve by calcium, though there is a slight benefit from its use. Pain due to the action of radium may have no relief.

In order to conserve time, I have abbreviated the case reports so that only the most salient points in each are mentioned.

CASE 1. Multiple metastases from mammary carcinoma. Mrs. M. M., aged thirty-eight. Dr. H. Patient had multiple metastases in the ribs, skull, pelvic girdle, vertebrae and femur. These caused severe pain and she noticed that when the pain was in the leg there seemed to be a muscular weakness also. Pain was present in the ribs and under the shoulder. This patient was relieved by the injection of calcium; one injection only was required to give entire

relief. This particular reaction was rather unusual in that the pain which was relieved was due to metastases in the bone. However, none of the metastatic growths in this case was large enough to have produced pressure on the cortex. (Calcium action upon the cancer tissues would not relieve the pain due to such pressure.) In this instance the pain was probably due to disturbances in the metabolism of the bone itself, in which type of case relief by calcium administration occurs almost uniformly.

CASE II. *Metastatic carcinoma of mesenteric glands after operation for neoplasm of cecum.* Mr. P. K., aged sixty-one. The patient reported that in every instance on the day following the administration of calcium chloride intravenously he would experience some pain the next morning (a soreness as he described it) rather than an acute pain. The soreness or the pain in the abdomen (where the neoplasm was located) would be absent for four or five days after this reaction—pain due to the calcium administration, and then would again return.

This temporary increase of pain in the neoplasm after the administration of calcium has been noted in several patients, particularly in those in whom the calcium treatment is forced.

CASE III. *Metastatic and recurrent carcinoma of breast.* Mrs. D. L., aged twenty-seven. At eighteen years this patient noticed a lump in the breast the size of a cherry. For six years it did not appear to grow, but was tender at times. In 1928 the nodule was removed by Dr. W. In the summer of 1929 the lump reappeared at the same place. Dr. D. did a local excision. After microscopic examination he advised amputation, which was done in August, 1929. In October, 1929 a lump appeared in the supraclavicular region which was removed under local anesthesia by Dr. E. In December, 1929 a series of two x-ray treatments (5 min. each) were given. In January, 1930 there was no evidence of skin recurrence, no palpable glands in either axilla or neck. Radium treatments were instituted at Baltimore between January 13, 1930 and January 27, 1930, over the right supraclavicular region and the right axilla. On January 13 x-ray exposure of a full dosage over the right axillary fold was given. On February 27 a mass was found immediately to the right of the upper portion of the sternum. This received 9 gram hours of radium at a distance of 2 inches. On April 12, another mass was found

on the right lower chest and was given an exposure of 2 gram hours at one inch distance. Neuralgic pains developed in the right shoulder and she was given further radium treatments.

On May 19, 1931 the patient entered St. Joseph's Hospital, complaining of severe pain in the right shoulder and arm radiating to the tips of the fingers, and to the scapula. The pain was sharp, stinging and pricking, it came and went quickly, was rather severe; it was worse about one hour after she received her radium treatments. She had been taking about 2 to 4 grains of morphine daily. Patient was given 1 ampoule of calcium gluconate on May 19, 1931, May 20, 1931 and on May 21, 1931. On May 21, 1931 she stated that the pain in the arm was better and the pain in the chest was better, but not entirely relieved. An ice cap to the chest relieved her and she had no pain. On May 24, 1931 she had no calcium and the pain returned. On May 25, 1931 it was noted that the metastatic nodules toward the right shoulder seemed smaller. On May 26, 1931 at 4:30 P.M. she complained of pain in the chest. Calcium gluconate was given and it was noted at 8:00 P.M. the pain was relieved. On May 27, 1931 the pains were relieved. On May 28, 1931 it was noted that the patient had had no pain for the past forty-eight hours, felt improved. Patient returned home. The improvement did not continue. The metastatic nodules increased in size, the arm became swollen and very painful. This pain was not relieved by calcium, although it could be controlled by 1 grain of codeine twice a day. Patient died in September, 1931. In this patient it is to be noted that the pain was fairly well controlled until the pressure on the axillary nerves caused the radiating pains in the arms. These pressure pains were not controlled by calcium.

CASE IV. *Carcinoma of cecum and terminal ileum.* Mrs. M. S., aged fifty-five, presented an inoperable carcinoma of the cecum and terminal ileum. The patient had been taking large quantities of morphine, but after being given calcium gluconate, only a few doses of 1 dram of paregoric were required to relieve the pain. No morphine was administered. The patient was first treated by calcium on October 21, 1929 and was free from pain on November 14, 1929, or in twenty-three days, and from that time was almost entirely free of pain till her death on January 16, 1930.

CASE V. *Adenocarcinoma of cervix uteri. Multiple metastases.* Mrs. M. H., aged forty. Cancer of the cervix uteri, metastases to the chest wall and metastatic bone lesions involved the ribs and sacrum. Recurring pains due to the disease were relieved in two days by calcium gluconate, 1 ampoule, 1 gm. every second day, given intramuscularly. She had a blood calcium of 17 mg. at this time. Patient did not continue the calcium treatments. Went to another hospital, had deep therapy, and died in four months.

CASE VI. *Carcinoma of cervix uteri.* Mrs. E. S., aged thirty-six. The pains which were severe and continuous and were felt in the lower abdomen, the pelvis and the back, were relieved with 3 ampoules of calcium gluconate (one daily for three days). The patient lived five days after entering the hospital. Relief of pain occurred within a few hours after the first injection of calcium gluconate. This patient had been getting as high as 2 grains of morphine daily before entrance into the hospital. After the calcium was given the morphine was stopped.

CASE VII. *Adenocarcinoma of esophagus.* Mrs. G. F., aged forty-five. The pain was controlled up to the time of death by calcium gluconate administered intramuscularly. When pain would recur the relief was immediate on the administration of calcium. This patient was in the hospital six weeks. A gastrostomy was done and death was due to bronchopneumonia. Autopsy showed an adenocarcinoma of the middle third of the esophagus and carcinomatous infiltration of the neck.

CASE VIII. *Adenocarcinoma of rectum.* Mrs. M. V., aged sixty-two. The patient was in great and constant aching pain, which at times was beating. The pain was localized around the anus and in the pelvis. On July 16, 1930, one ampoule of calcium gluconate was given intramuscularly, and in forty-eight hours another ampoule was given. On every third day an ampoule of calcium gluconate was given. Only once, on July 23, 1930, was it necessary to administer a narcotic (pantopon). The discomfort from which the patient suffered rapidly disappeared until on September 1, 1930 she acknowledged that there "was no more pain." In this case, with minimal calcium treatment, the pain was entirely relieved in forty-six days and the patient was pain-free for over three months, after which the treatment was neglected and the pain returned.

CASE IX. *Adenocarcinoma of cervix uteri.* Mrs. M. M., aged fifty-one. The progress notes on this patient state that the pain was relieved by the administration of calcium gluconate, though the time interval is not recorded. It is stated, however, that when the administration was discontinued the pain returned, again to be controlled after the calcium gluconate had been given daily for three days. On September 10, 1930, the calcium was discontinued because of nausea and vomiting, and the patient remained free from pain until the time of her death on October 2, 1930. In this case there was apparently a continued effect of the calcium, even after its administration had been stopped. This extension of the effect of calcium long beyond the period of its discontinuance has been noticed in many patients.

CASE X. *Adenocarcinoma of breast with substernal metastases.* Mrs. M. L., aged thirty-six. Dr. R. W. L. The patient complained of pain under the sternum radiating to both sides which had been previously controlled by the administration of three $\frac{1}{4}$ grain tablets of morphine every twenty-four hours. It was found that the morphine could be discontinued after three injections of calcium gluconate over a period of four days, and the patient remained entirely free from pain, with calcium gluconate injections every other day. It was impossible to follow this case further because of the fact that the patient left the city. It was reported she had recently died.

CASE XI. *Carcinoma of sigmoid.* Mr. J. D. From August 6, 1929 until Aug. 15, 1929 the patient had had severe pain which was controlled by the administration of morphine and pantopon. On August 13, calcium gluconate was administered intramuscularly. On August 15 calcium chloride gm. 1.0 was given intravenously and on August 16 and the 20 calcium gluconate was again given intramuscularly. On August 28, 1929 the patient was completely free of pain. Calcium gluconate was given every fourth day. On October 30, 1929 pain developed due to urinary retention and was not controlled by the administration of calcium gluconate. On November 26, 1929 it was necessary to administer pantopon for the control of pain, the result of a severe cystitis and retention of urine. The patient died on December 31, 1929.

In practically all of the cases cited, the patients had been previously treated with

morphine to control the pain, or else had suffered pain which had not been relieved. In the former group, calcium treatment after a few days replaced the morphine, and the patient was apparently more comfortable than under the administration of narcotics, while in the latter group pain was uniformly controlled. Calcium not only relieved the pain, but produced a buoyant feeling in the patient, resulting in the resumption, in many cases, of individual activities. This attribute, alone, makes *calcium most valuable in the therapy of cancer.*

Pain due to bone metastases was not as certainly and uniformly relieved by calcium treatment as was that of cancer confined to other tissues. A reason for this may be that pain production in bone metastases is in a large measure due to the pressure exerted on the cortex of the bone and the periosteum by the constantly enlarging tumor. This pressure is not relieved by calcium treatment.

Reduction in the volume of the tumor by the action of the calcium on the cells, and lessening of the irritative perineoplastic and intraneoplastic tissue juices by the calcium is of only temporary benefit and lasts only until the size and magnitude of the tumor outbalance the beneficial changes produced by the calcium.

SUMMARY

Every patient affected with cancer has pain at some period of the disease. This can be controlled by narcotics in constantly increasing dosage. Calcium may be substituted for narcotics. It either entirely controls the pain or greatly reduces it. Calcium is not harmful and seems to have a curative action on the cancer tissue. It acts by decreasing cell permeability, lessening edema, reducing glycolysis and decreasing the sensitivity both of nerves and nerve centers. In all my cases it has had a beneficial influence.



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VESICOVAGINAL FISTULAS TREATED BY ELECTROCOAGULATION*

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CASE I. In October, 1922, I examined a married woman thirty-five years of age who gave a history of an operation for the removal of the uterus, for fibroids, four months previously.

Ten days following this operation a watery discharge began to drain from the abdominal wound. This, on examination, was found to be urine. Shortly after this urine began to discharge through the vagina. The abdominal fistula closed following applications of nitrate of silver but the urine continued to discharge through the vagina. The patient was constantly wet with urine and had great difficulty in taking care of herself. She slept on a bedpan to keep from saturating the bed.

Combined cystoscopic and vaginal examination revealed a fistula in the right bladder base above the right meatus. A No. 6 ureteral catheter could be passed through this opening. The irrigating fluid drained out quite rapidly.

I had previously employed electrocoagulation in the treatment of postoperative fistulas following both perineal and suprapubic operations in the male and considered the advisability of using this conservative method here. The surgical attack in this case would have been difficult as the opening was located high up to the side of the cervical stump.

Electrocoagulation was carried out both from the bladder and vaginal side, the current was applied until the surrounding tissue showed a blanched-out appearance.

During the first few days following the electrocoagulation there was very little drainage of urine through the vagina, but soon the condition was as bad as before for a period of about two weeks. The patient returned for examination in November, 1922, and reported considerable improvement, at this time voiding several ounces. Electrocoagulation was again carried out, with a Bugbee flexible electrode from the bladder side, and a stiff electrode on the vaginal side, employing for

exposure a lighted vaginal speculum. The patient returned for examination on December 12, and reported that no urine had leaked for about two weeks.

I have not seen the patient since but have learned through the surgeon who performed the hysterectomy that there has been no return of the fistula and that the bladder function is normal.

CASE II. Electrocoagulation was used again on a woman forty years of age, suffering from two vesicovaginal fistulas following the removal of a large uterine fibroid.

The surgeon stated that he had encountered considerable difficulty in dissecting the bladder from the tumor.

Urinary leakage developed shortly after the operation. It was necessary for the patient to have a receptacle for urine in bed and to wear pads during the day.

Cystoscopic examination, April 17, 1929, showed an irregular sacculation 2 cm. above the trigone. It was impossible satisfactorily to distend the bladder with fluid for careful inspection. Upon filling the bladder with methylene blue solution and inspecting the vagina two fistulous openings were demonstrated well up in the lateral walls. The opening on the right emitted the blue fluid quite rapidly.

Electrocoagulation was recommended as a trial to this patient and was carried out at intervals of from ten days to three weeks, both through the cystoscope and from the vaginal side. This case proved more stubborn and it required six applications, over a period of three months, to effect a closure.

An examination on October 21, 1929, showed firmly healed scars and the bladder capacity and function were normal.

A review of the literature shows only one report upon this method of treatment of vesicovaginal fistula, made by Dr. Karl

* Submitted for publication September 16, 1931.

Hellmuth,¹ from the University Women's Clinic, Wurzburg. He quotes Dr. B. Ottow² who, in 1927, reported the cure of a vesicovaginal fistula by electrocoagulation; and gives a report of one patient with a vesicovaginal fistula following hysterectomy. One application of the current caused the fistula to heal. The patient was examined one year afterwards and found dry.

Hellmuth placed a retention catheter in the urethra for ten days and applied the current only from the bladder side. He also states that this conservative method is applicable only to small fistulas without dense scar tissue.

In conclusion I wish to emphasize that surgical repair of vesicovaginal fistulas is frequently not free from failure and difficulties and that electrocoagulation may be tried in closing fistulas of small caliber.

DISCUSSION

DR. FRANCIS L. ANTON: Dr. Peterson's report of his treatment of vesico-vaginal fistulas by electrocoagulation and of his

successful closure of these fistulas is a very valuable contribution to the treatment of this very troublesome condition. It is especially welcome to find such a simple procedure have such splendid results, especially because it is most applicable to small fistulas as it is these small fistulas that give the surgeon the greatest trouble and chagrin. It is certainly a miserable experience to find, after having carefully dissected out a very small fistulous tract and repaired it in the orthodox manner, by two or three layers of sutures, that the whole or a greater part of the suture breaks down and the patient returns with a condition much worse than before the operation; whereas, a large fistula presents frequently much less difficulty because one necessarily does a more extensive dissection, and in that way, we generally reach out beyond all scar tissue to tissues that have a more normal circulation. When these tissues are brought into contact, healing is more certain.

DR. JAMES F. PERCY: As reported by the author neither of his patients' fistulas involved a ureteral orifice. When this occurs nothing but surgery will repair the condition so as to preserve the function of the involved ureter.

The chief factor behind nearly all of these small fistulas is redundant mucous membrane protruding from within the bladder. Destroying this membrane by surgical diathermy as described by Dr. Peterson, or with the actual cautery, frequently gives most gratifying results as has been reported.



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* Continued from p. 236.

VAGINAL URETEROLITHOTOMY*

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AT times extraperitoneal abdominal ureterolithotomy for stone situated in the lower or juxtavesical portion of the ureter is most difficult, especially in fat women with deep pelves. In some cases it is necessary to divide the round ligament, the broad ligament, and the uterine artery to gain access to the stone. Then there is the problem of infection from drainage, and the possibility of an incisional hernia.

Two years ago in Vienna I saw Weibel do two vaginal hysterectomies for carcinoma of the cervix according to the Schauta technique and was impressed with the ease with which he could free the lower ureter. Stoeckel† described this operation and demonstrated the facility with which the ureter could be exposed.

In looking over the literature I find that vaginal ureterolithotomy has been done relatively infrequently. Most operators have cut down upon the stone after locating it by vaginal palpation, and in only a few instances has there been any methodical procedure of exposing the ureter.

Lower reported 6 cases; Garceau 2. Most of the others have referred to single experiences. The fear of a ureterovaginal sinus has deterred many from attempting this procedure; but from the experience of those who have reported cases, this has not seemed to be a troublesome factor.

Early this year there came under my care a patient with a stone in the lower end of the right ureter that seemed especially suitable for removal. This was done with such satisfactory results that I took up the problem of determining which cases were suitable for the vaginal operation, and of developing a technique.

Only those stones that could not be made to pass, displaced upwards or be removed by some conservative technique,

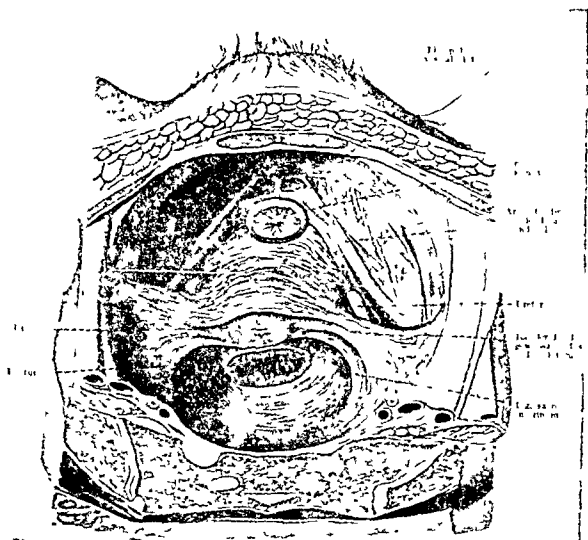


FIG. 1. Thickened portions of urogenital fascia around vagina, uterus and rectum. (After J. Tandler in Stoeckel-Veit, *Handb. d. Gynaek.*)

were considered operable. After work upon the cadaver it was found that stones in the juxtavesical portion of the ureter anterior to the uterine artery (the lower $1\frac{1}{4}$ inches of the ureter) would be suitable for vaginal removal; the portion of the ureter on the kidney side of the uterine artery would be much more difficult to expose. Those in the transvesical portion, not suitable for transvesical operation, might also be considered suitable. If the stone can be palpated, its relation to the uterus at the cervico-uterine junction should be noted, for it is at this point that the ureter passes under the uterine artery. If the uterus is anteverted the stone will be farther forward in the pelvis than when the uterus lies backwards. (See Fig. 4.) The kidney must not be

† *Zentralbl. f. Gynaek.*, Jan. 3, 1931.

* Read before the Southern Surgical Association, December 9, 1931.

destroyed, and its function should be capable of improvement after the removal of the stone.

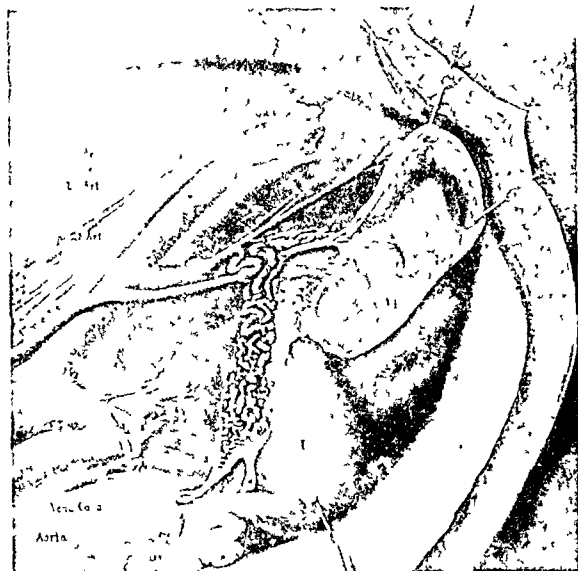


FIG. 2. Relation of ureter to uterine vessels as seen from above. (From Kelly.²⁰)

In women the x-ray does not always give the correct relation of a stone to the vesical end of the ureter, as the ureter

However, it is suggested that some standard technique be used in the location of the stones; I would suggest a 25 inch target-to-film distance and that with the patient in the dorsal position, the central ray be perpendicular to a spot midway between the superior border of the symphysis and the navel. I have had an opportunity to make some x-ray pictures on the cadaver in which the foregoing technique was used. The cadaver was an adult female with an intact pelvic floor. The markers were pins on which a drop of solder had been fused. The heads of the pins nearest the symphysis are at the entrance of the ureter into the bladder wall, and the heads of those cephalad mark the ureter where it passes beneath the uterine artery. The first picture is of the uterus in anteversion and the second with the uterus retroverted. Of course I realize the inclination of the pelvis to the table will cause a variation in the shadow on the film. However, with this technique, the probable location of the stone can be determined in persons without malposi-

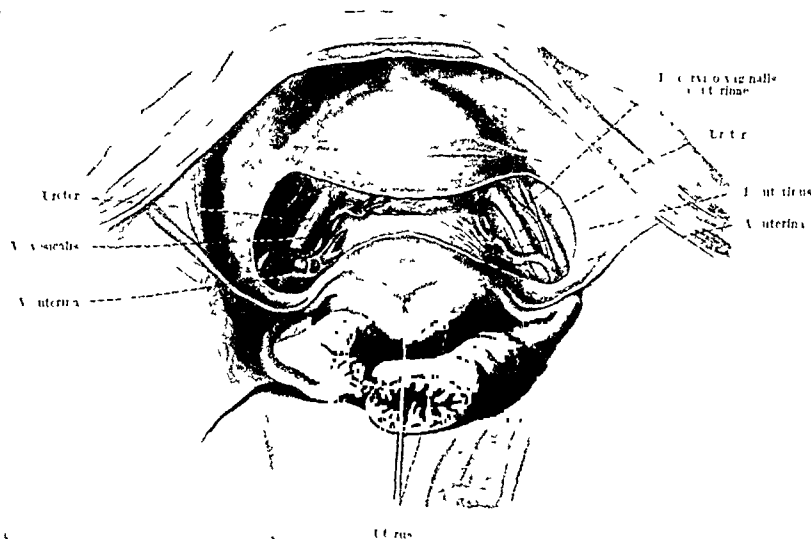


FIG. 3. Portion of ureter anterior to uterine vessels. This is the portion from which stones are best removed per vaginam. (After J. Tandler in Stoeckel-Veit, *Handb. d. Gynaek.*)

may be displaced by malposition of the uterus, cystocele, and prolapse, as well as the presence of new growths and inflammatory conditions.

tions of the uterus or of the vaginal wall. In a woman with uterus of normal size and position and an intact pelvic floor, the shadow of a calculus at the uretero-

vesical junction should lie approximately 2.6 cm. above the shadow of the symphysis, and the shadow of a stone in the ureter as it

drawn well downwards, sufficient room can be obtained by making a Schuchardt incision in either or both vaginal sulci.

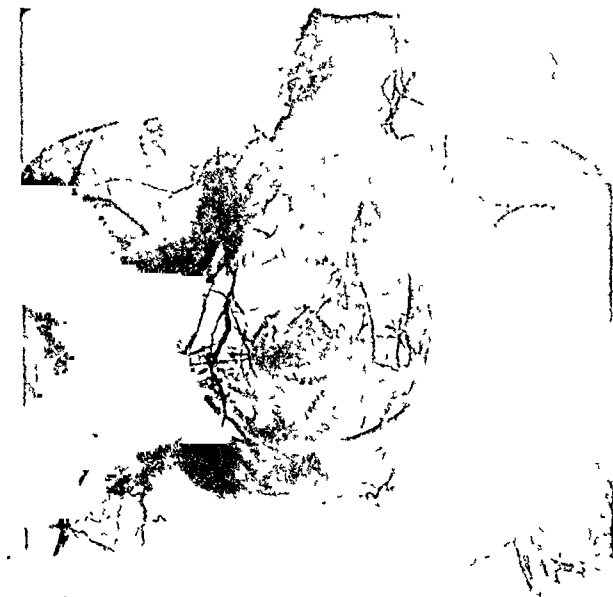


FIG. 4. Heads of pins are used as markers. Lower two are placed at uterovesical junction. Upper two are where ureter passes under uterine artery. Uterus is in anteversion. Film-target distance is 25 inches. Central ray strikes a point in midline, midway between symphysis and umbilicus.

passes beneath the uterine artery should be 4.8 cm. above the symphysis shadow; with the uterus retroverted, 1.2 cm. caudad to this.

In most instances the position of the stone in the ureter can be better located with a catheter, but occasionally one is unable to make a catheter enter the ureter and in a few the catheter will pass the stone without resistance. Intravenous pyelography is also of great value.

The anatomy of the pelvic ureter is shown in Figures 1 and 2.

The portion of the broad ligament where the ureter passes beneath the uterine artery is described as Schauta's *Schlitt*. In approaching the ureter through a vaginal incision it must be remembered that the ureter will be found below and to the outer side of the uterine artery.

OPERATION

The lithotomy position is used. If the vagina is small, or the uterus cannot be

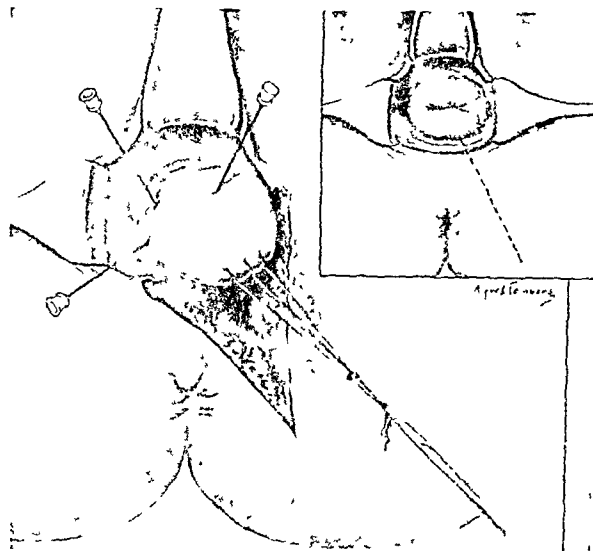


FIG. 5. Dotted line in insert outlines Schuchardt incision. Needles represent location in which adrenalin solution to produce ischemia is injected. Vesico-uterine and parametrial tissues on involved side are also infiltrated.

This incision begins high in the vagina and extends through the transversus perinei and the levator ani muscles in a backward and outward direction almost to the tuberosity of the ischium. It is well not to bring it too close to the sphincter ani for fear of disturbing its innervation with consequent partial incontinence. Infiltrating the tissues to be incised with adrenalin chloride solution (9 drops of 1:1000 solution to each 100 c.c. of saline) will prevent troublesome oozing. Vessels that bleed are clamped and ligated.

Three stout sutures are passed through the two lips of the cervix, tied, and the long ends clamped together to act as a tractor. The anterior wall of the vagina, the vesico-uterine connective tissue and that of the parametrium on the side of the stone are infiltrated with the same adrenalin solution, from 50 to 75 c.c. being used for this purpose. The ischemia so induced makes dissection easier, and bleeding is almost nil. If the vessels that are seen to bleed are promptly ligated there is little fear of subsequent hemorrhage.

An incision is made over the anterior vaginal wall in a transverse direction from slightly to the side of the cervix

fibers running in an anteroposterior direction attached below to the cervix, forming the bladder pillars. These are now sepa-

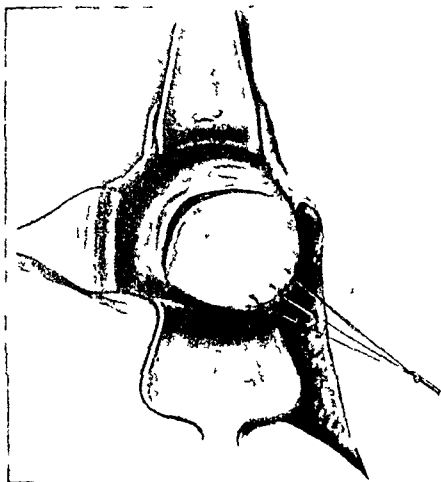


FIG. 6.

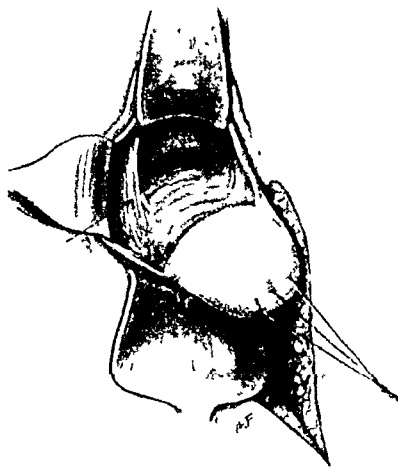


FIG. 7.

FIG. 6. Uterus drawn downward and to side opposite that of stone. Outline of mucosal incision.

FIG. 7. Bladder has been freed in midline from anterior surface of cervix. On either side are seen pillars of bladder.

opposite the stone, over its body, to well behind the uterine artery on the side of the stone. By dissection in the areolar tissue that lies between the bladder and

rated from the cervix on the side of the stone with a few snips of the scissors. A few small vessels here need ligation. By scissor dissection along the lateral

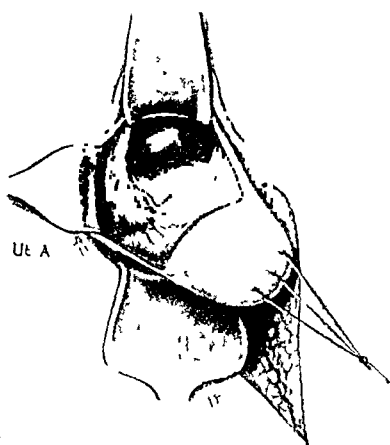


FIG. 8.

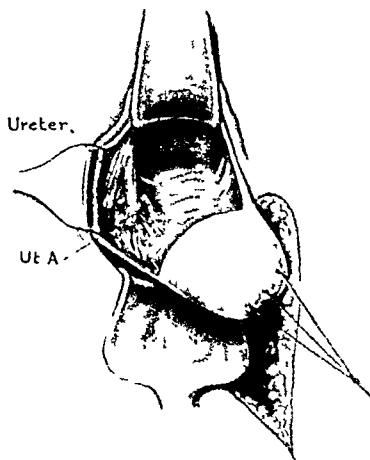


FIG. 9.

FIG. 8. Freeing pillars and slight dissection along lateral margin of cervix brings into view uterine artery. When fibers to cervix are freed, there may be some bleeding, which should be controlled by suture ligation.

FIG. 9. Following uterine artery will bring one to ureter. Traction downward on cervix (and uterine artery) will cause ureter to be kinked and to present as a knee. From this point forward ureter is easily freed to bladder. Ureter is usually found a bit farther outwards than appears in drawing.

the cervix, the bladder is separated in the median line as high as the vesicouterine peritoneum. On either side will be seen

border of the cervix the uterine artery will be brought into view. Traction downwards and to the opposite side of the

cervix will cause the ureter to descend and to be kinked by the uterine artery; following the uterine artery will invariably lead to the ureter, which will appear as a whitish shining structure. It must be remembered that the ureter is in the parametrium and not close to the cervix. Fortunately in all instances of stone large enough to necessitate removal, the ureter is so dilated and thickened as to make its recognition easier. After freeing the ureter, it is well to place an Allis clamp around it above the stone to prevent the latter's being dislodged upwards. In two of Lower's cases the stones slipped upward beyond reach. The ureter is exposed in front of the clamp, and if possible another Allis clamp applied on the other side of the stone. Between the clamps the ureter is incised longitudinally and the stone delivered. A tapered bougie is then passed into the bladder to dilate any portion of the ureter that may be strictured. If the ureter can be easily sutured, a few stitches with fine plain catgut are taken; if one is in doubt, it is better to leave the ureter open as the sutures may cause pressure

necrosis. The vaginal wound is best closed with interrupted sutures of silkworm gut, with a strip of rubber tissue into the parametrium. The Schuchardt incision is closed with continuous layer sutures of chromic catgut, ten day, No. 1. The vagina is packed with iodoform gauze. This prevents, to some extent, any troublesome bleeding that may occur.

The iodoform gauze and the rubber tissue drain are removed in forty-eight hours.

In practically all of the reported cases convalescence has been smooth. In a few drainage has lasted more than a week (in one twenty-one days) but usually it is of only a few days' duration. Six to seven days in bed are sufficient.

My experience with this method has been quite limited, but I believe that in properly selected cases it will prove to be the method of choice.

It strikes me that it is better to free the ureter by a well-planned anatomical dissection, and then remove the stone, than to cut down upon the stone by the sense of touch.

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[For Remainder of References see p. 258.]

NEW METHOD OF INSTITUTING AIR-TIGHT PLEURAL DRAINAGE*

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THE occasion to institute air-tight pleural drainage frequently arises in the treatment of empyema and pyo-

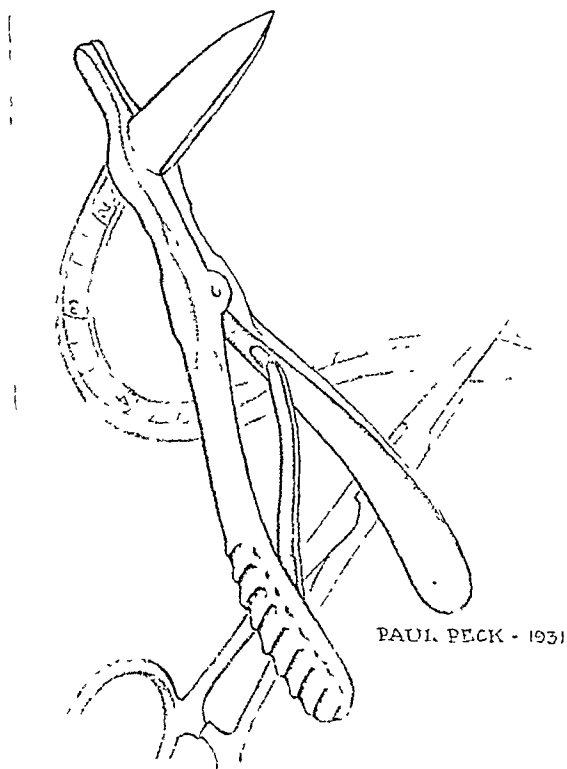


FIG. 1. Tube introducer and drainage tube ready for introduction. Note proximal end of tube clamped off.

pneumothorax, especially in children. Two methods of introducing drainage tubes are commonly employed.

The first commonly employed method involves the use of the familiar trocar and cannula. The usual procedure instituted is as follows: A small skin incision is made after the purulent collection has been located with the aspirating needle. The

assembled trocar and cannula are then introduced through an intercostal space into the empyema cavity. The trocar is next withdrawn, and the drainage tube, with its proximal end clamped off, is introduced through the lumen of the cannula. Finally the cannula is removed, leaving the tube in place. The objections to this method are as follows:

1. The sudden gush of pus which follows the removal of the trocar sometimes makes introduction of the tube difficult, and often causes a too-sudden decompression of the lung.

2. Air may enter the chest between the time that the trocar is withdrawn and the tube is introduced, regardless of the rapidity with which these manoeuvres are completed.

3. The size of the tube to be introduced is limited by the size of the cannula (whether it be round or oval in cross-section) and by the width of the intercostal space through which it is to be introduced.

4. The tube may be accidentally withdrawn during the process of introduction, because as one attempts to slip the cannula over the tube, after the tube has been introduced, the clamp on the free end of the tube impedes the removal of the cannula. This necessitates the application of a second clamp to the tube, at a point between the chest wall and the withdrawn cannula, before the first clamp can be removed to permit the discarding of the cannula.

The second commonly employed method of introducing the drainage tube may be described as follows: A small skin incision to expose the intercostal space is made in

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the area at the site of the proposed drainage, after pus has been located with the aspirating needle. The distal end of the

ducer, which resembles somewhat a long-bladed, hollowed-out nasal speculum. The blades, which are about 2 inches long and

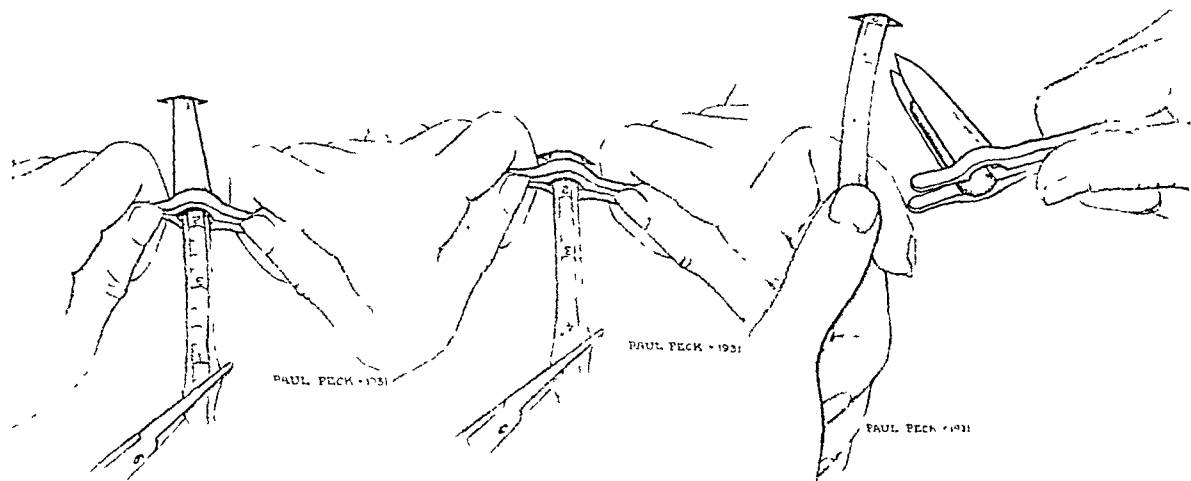


FIG. 2.

FIG. 3.

FIG. 4.

FIG. 2. Small skin incision has been made. Instrument is being introduced into empyema cavity through an intercostal space.

FIG. 3. Introduction of instrument almost completed.

FIG. 4. Instrument being withdrawn while free hand steadies tube in situ.

drainage tube is grasped between the jaws of an artery forceps, after the proximal end of the tube has been clamped off. The artery forceps grasping the distal end of the tube is then plunged through the intercostal space into the empyema cavity. The objections to this method are as follows:

1. Excessive trauma is produced.
2. If the tube does not enter the chest readily, an attempt to stretch the opening made with the forceps results in the production of an opening which is elliptical in shape rather than one which is round. This further increases the difficulty of introducing the tube. In the meantime, pus may rapidly flow out and air enter, thus resulting in conditions which the surgeon is specifically attempting to avoid.

In an attempt to obviate the difficulties and disadvantages inherent in the aforementioned two methods, a new method which embodies the favorable features of both of the older methods for introducing the tube was devised. This method, which has proved highly satisfactory, involves the use of a new instrument, a tube intro-

$\frac{3}{8}$ inch wide, taper distally to form sharp points. The instrument permits the introduction of tubes ranging up to No. 32 gauge (French). This size we have found adequate, but if one desires to introduce a tube of larger caliber the instrument may be constructed on a slightly larger scale.

In using the device, the bevelled distal end of the tube to be introduced is placed forward within the hollow of the instrument for as great a distance as will allow the pointed ends of the blades to remain in contact. It is now held firmly grasped by the two broad hollowed-out blades which compress it from above and below. (Fig. 1.) A small skin incision is made and the intercostal space exposed, after the site of drainage has been determined by locating pus with the aspirating needle. The sharp instrument carrying the distal end of the tube is then gently forced into the chest, the proximal free end of the tube having previously been closed by a clamp. (Figs. 2 and 3.) The jaws are next opened, and while the surgeon's free hand steadies the tube, the instrument is withdrawn, leaving the tube in situ. (Fig. 4.) As the

instrument is being withdrawn, the intercostal muscles fall together about the tube, effectively sealing off the opening.

The instrument should always be introduced with the flat surfaces of its blades lying parallel to the long axis of the ribs. A point as low in the intercostal space as possible is chosen, in order to minimize the possibility of injuring the intercostal vessels. There is an area which extends approximately from the posterior axillary line to the nipple line, in which the intercostal spaces are wide and the ribs quite mobile. In this area, the blades can be spread apart readily as soon as they have entered the chest. (Fig. 4.)

In contrast to the area just described, there is a second area which extends approximately from the posterior axillary line to the posterior extremities of the ribs. In this area the intercostal spaces are narrow and the ribs can be spread apart only with difficulty, because of the poor leverage obtainable. When it is necessary to institute drainage here, the instrument is introduced in the same manner as previously described, but before the blades are spread, the handles are rotated clockwise through an arc of 90 degrees. This brings the flat surfaces of the blades to a position at right angles to the direction of the ribs. The blades can now be spread without difficulty because they will not impinge on the fixed ribs, above and below, but on the less resistant intercostal musculature which lies on each side.

If desired, a Pezzer catheter may be employed in place of the usual rubber drainage tube. Its introduction differs in no respect, except that it must be stretched over its stylet while being inserted in

order to diminish the diameter of the "mushroom."

The advantages of this new method are:

1. A minimum of trauma is produced.
2. There is little or no leakage of pus to cause too sudden decompression of the lung.
3. Little or no air enters the pleural cavity.
4. While the tube is being introduced, it is not readily displaceable.
5. A large tube can be used, because in certain regions noted above the instrument will separate the ribs if the jaws are widely spread, and thus a large-sized, snugly fitting tube can be introduced. This is an important point in so far as it has been our experience that secondary rib resection and drainage may be unnecessary, if the primary air-tight drainage has been performed using a tube of large caliber.

After the tube has been introduced into the empyema cavity and fixed in place, the free end of the tube can be connected with any type of device with which the surgeon prefers to maintain closed drainage. The clamp is finally released for a variable distance and the lung decompressed at the desired rate.

When this instrument is used in conjunction with the calibrated drainage tubes which we have previously described elsewhere¹ the surgeon is able to readily drain the chest in an air-tight manner, and at the same time introduce the drainage tube accurately to a point just within the empyema cavity without fear that the end of the tube will impinge on the underlying lung.

¹ Touroff, A. S.: W. Calibrated surgical drains. *Ann. Surg.*, Nov. 1931.



BIFURCATION OF THE SUBMAXILLARY DUCT*

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THIS case is reported because: (1) The paucity in the literature of cases of bifurcation of the submaxillary or Wharton's duct; (2) the difficulty in explaining this formation.

CASE HISTORY

A. W., aged thirty-four, female, white, married.

For the past five years, patient had noticed a swelling of the left submaxillary gland with occasional radiating pains to that side of the face, behind the head and neck. Pressure on the gland, externally, brought forth a small discharge on the floor of the left side of the mouth opposite the second molar. Occasionally, pressure over this swollen gland would produce a discharge on the floor of the mouth at the papilla at the side of the frenulum linguae. Most often, however, the discharge appeared opposite the second molar in the back of the mouth. The swelling of the gland would recede from time to time. Of late, the enlargement of the submaxillary gland has been recurring more frequently and has been giving the patient considerable pain. This gland would shrink up and the swelling disappear without any external application. There was no associated disturbance in the patient's teeth, her tonsils had been removed some time previously, and there was no pathology in the mouth itself which could account for the recurrent enlargement of the submaxillary gland.

Physical Examination: On the left side of the neck, below the mandible and in the submaxillary triangle, there was a large, swollen, firm, submaxillary gland not attached to the overlying skin and tissue. There was no fluctuation, nor was it tender to touch. With the mouth open, and with pressure on the undersurface of this gland, one could notice a slight discharge on the floor of the mouth opposite the second molar. There were no other associated glandular enlargements in the neck. The right submaxillary gland was normal. Stumps of pre-

viously removed tonsils were found, but no pus could be expressed from them. The remaining physical examination of the body was normal.

Diagnosis: Probable submaxillary calculus.

X-ray Examination: Reveals the presence of a calculus in the submaxillary triangle, apparently in Wharton's duct.

X-ray Diagnosis: Submaxillary calculus.

Operation for the excision of submaxillary calculus and gland, June 16, 1930, at the Yonkers Professional Hospital.

Under gas-oxygen ether, an incision was made on the left side of the neck on the level with the cricoid cartilage over the site of the submaxillary gland. The platysma was reflected. The capsule of the gland was cut and the latter exposed. It was freed of all adhesions surrounding it and lifted up out of the submaxillary triangle. The calculus was felt on the inferior surface of the gland. Inspection revealed that this calculus was situated in what appeared to be a small common Wharton's duct which bifurcated into anterior and posterior limbs: one limb running anteriorly and upwards apparently emptying at the papilla at the frenulum linguae; the posterior limb, apparently of equal caliber, width, and length, running backwards and upwards, seemed to empty in the floor of the mouth opposite the second molar. This accounted for the peculiar symptoms of which the patient complained. Both limbs of the duct were doubly ligated and the gland and calculus were excised. The wound was closed in layers. One small rubber tissue drain was inserted at the angle of the wound.

COMMENT

A search in the literature for cases presenting bifurcations of the submaxillary duct proved futile. In the case reported herein, the posterior limb may in reality have been a fistulous tract which occurred behind the obstruction caused by the

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calculus. It is possible that that portion of Wharton's duct behind the calculus may have become cystic and that this cyst, after suppuration, may have possibly but not necessarily, discharged itself into the mouth opposite the second molar. There would then have been two tracts, both opening into the mouth, one the real duct and the other a fistula with a fairly distinct wall, closely resembling the original Wharton's duct. If a cyst had occurred, as suggested, it would have disappeared as such at the time of the operation, its wall being represented as the posterior duct. The difficulty in accepting the posterior limb of the duct as such is entirely due to the difficulty in explaining in detail how this bifurcation may have arisen. The salivary glands are generally supposed to

be ectodermal in origin, that is to say, derived from the stomodeum and not from the embryonic (entodermal) pharynx. The stomodeum is believed to form only a small part of the floor of the mouth (the part anterior to the tongue) although it forms the whole of the roof. If the submaxillary gland is really ectodermal, its duct (the stalk of the gland, so to speak) is not likely to arise from a part of the mouth known to be entodermal in origin. There is great difficulty, however, in determining the exact boundary the ectodermal and entodermal regions of the mouth and there is therefore some doubt as to whether the entoderm does not take some share in the formation of the salivary glands.*

* Senior, Prof. H. D. Personal Communication.



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* Continued from page 253.

BIOPHYSICAL FACTORS CONCERNED IN THE CLINICAL COURSE OF CARCINOMA OF THE UTERINE CERVIX*

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PREDILECTION OF CARCINOMA FOR UTERINE CERVIX. The predilection which genital carcinoma unquestionably shows for the cervical portion of the uterus is so striking that the reason might well be sought in the developmental background or in some anatomical or physiologic peculiarity of the structure which this neoplasm selects in adult life. It is not the incidence of cancer that is considered in this study, but rather the biological and physical factors which play a part in its subsequent behavior.

EFFECT OF MUSCLE TISSUE ON CANCER EXTENSION. When in the course of developmental evolution, the upper portions of the two ducts of Mueller become the fallopian tubes, the middle and lower portions coalesce to form the uterus and vagina, hollow muscular organs which are covered with peritoneum and lined by mucous membrane.

An invading carcinoma does not perforate preformed muscle layers readily, but grows along the natural planes of cleavage where the lymphatics lie. The general disposition of the muscle tissue therefore may have a certain bearing on the way in which carcinoma extends in a muscular organ. It is not difficult to see why this applies rather to the spread of carcinoma in the body of the uterus than in the cervix itself.

CARCINOMA SPRINGS FROM EPITHELIUM. Carcinoma is an epithelial neoplasm. While muscle planes and connective tissue spaces which lead to lymphatic routes may help to determine the paths of least resistance, these tissues must nevertheless be subordinate in their significance, to the epithelium itself from which the cancer springs.

At that moment when the normal behavior and potency of embryonal as well as adult tissue are more clearly understood, it will become easier to detect the epithelial aberrations which take place in cancer.

Scanned from the developmental viewpoint, the epithelium of the vulva, including the vestibule, is ectodermal, while that which belongs to the vagina, uterus and tubes, the structures derived from Mueller's ducts, is mesodermal. Histologically speaking, stratified squamous epithelium continues from the cutaneous to the mucous surface of the labia majora. It covers in continuity the vulvar mucous membrane, the vaginal canal and vaginal aspect of the cervix. At the external os, normally, is the line of transition to the single layered columnar epithelium which invests the cervical canal and uterine cavity and extends throughout the fallopian tubes.

CHARACTER AND DISTRIBUTION OF EPITHELIUM. The epithelium which protects the vagina and exocervix is therefore of the same general structure as that which covers the surface of the body and is better adapted to withstand insults than the delicate cylindrical epithelium in the less exposed and more inaccessible uterotubal segment.

CONGENITAL PSEUDOEROSION. When in the third month of intrauterine life, the indifferent epithelium of what is to become the fetal cervix differentiates into the glandular or "cylindrical" and the squamous types, the squamous epithelium at first lines a large part of the cervical canal but is later encroached upon by the maturing glandular epithelium with its glands and mucous cells. In fact even an extension of the glandular epithelium beyond the

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external os may be apparent after birth and constitute what has been called the congenital pseudo-erosion.

EPITRACHELITIS GRANULOSA. In *adult* life, the normal line of transition is at the external os. An ectropion, or eversion of the endocervix which is due to a cervical laceration, is to be distinguished from the true erosion which is perhaps more accurately designated *epitrachelitis granulosa* or simply, circumscribed epitrachelitis.

RECIPROCAL RELATIONS OF SQUAMOUS AND CYLINDRICAL EPITHELIUM AT EXTERNAL OS. When the endocervix is in a catarrhal state, there is increased desquamation of the vaginal portion of the cervix or exocervix so that some areas may be completely deprived of epithelium, particularly near the external os from which the cervical discharge issues. Under these circumstances the conditions are favorable for the extension of the translucent endocervical epithelium to the denuded area. There may be a small patch of migrated endocervical epithelium covering a deep red surface of the anterior and posterior lips, or it may encircle the external os completely.

When the cervical discharge ceases or the area is treated by repeated application of a solution of silver nitrate, the erosion disappears and squamous epithelium again takes its place. This reciprocal replacement depends not so much on a harder growth as on whether the local conditions are more favorable for the proliferation of the one or the other type of epithelium. Thus the catarrhal discharge which accompanies cervical inflammation causes the surface epithelium to be cast off in patches and macerates it, while the glandular epithelium is relatively tolerant and may even grow out over a raw area before the inflammatory exudate has disappeared.

MICROMECHANICS OF EPITHELIAL CELL REPLACEMENT. The ingrowth of new squamous epithelium takes place from the basal layer. At first the advancing edge is thin and tapering. The basal cell grows in height and the nucleus divides. One

daughter cell is pushed toward the surface to undergo further differentiation into a polygonal form initially and finally to become more flattened in order to serve its protective purpose. The other daughter cell merely replaces the parent cell in the basal layer. Other basal cells however undergo cell division in a different plane, so that the cells in the basal layer also become numerically increased.

The effect of cell division in the basal layer is therefore twofold. While the thickness of the polygonal and squamous cell strata becomes more pronounced, the multiplication of other basal cells leads to crowding in the basal layer and creates an undulating outline. When cell-division becomes greatly exaggerated as the result of recurrent irritation from local inflammation of low grade intensity, actual downgrowths of the basal epithelium occur.

EFFECT OF LOCAL IRRITATION. Under these conditions of irritation the young cells are provoked to undergo cell-division prematurely and under the stress of irritation the offspring becomes progressively more atypical. Cell reproduction is impelled to continue under morbid conditions. In the beginning the cellular metabolism is merely exaggerated. Anabolism is active and the reserve supply is sufficient. But rapidly the process of dissolution exceeds the assimilating activities within the deteriorating cells. Even the staining properties reveal the serious derangement in the intracellular processes. The irregular nuclei are blurred in outline and the cells look as if cytoplasmic material had escaped into the surroundings. The alignment of the basal layer may be broken and cells make their escape into subjacent tissues. K. V. Bailey has recently made some excellent studies in these directions and attempted to establish a relationship between the micromechanics of epithelial behavior in recurrent infective inflammation of the cervix and incipient cancer.

DIFFERENCE BETWEEN IRRITATION FORMS AND TRUE TUMOR CELLS. So far, it has not been shown conclusively that

the atypical irritation forms which occasionally are seen in inflammatory lesions may acquire autonomy in the sense that they can continue to divide anomalously either when the irritation ceases or after the removal of the irritated cells by metastatic displacement; and this is the keynote of the requirements imposed by malignancy.

SIGNIFICANCE OF TRAUMA. Formerly mechanical irritation as well as chronic inflammation was held to be intimately associated with tumor production. With a broader view of the biological character of cervical cancer much less importance is attached today to the relation of mechanical irritation or trauma to tumor incidence. If there were anything determining in the laceration itself, why does the carcinoma not, as a rule, have its beginning in or near the actual site of the injury? Since cervical tears most commonly are lateral, why does the carcinoma usually start in the anterior or posterior lip instead of beginning in the cervical angle? If the carcinoma is closely related to the tissue damage which has been sustained during childbearing, why do the statistics of the Woman's Hospital of New York City according to Lilian K. P. Farrar show that in 41.7 per cent cervical cancer occurs as late as ten to twenty years after the last pregnancy? And 24.4 per cent not until twenty to thirty years have elapsed? In a recent discussion, it interested me greatly to learn that H. Schmitz contends that cancer of the cervix is not more frequent in women who have borne children than in those who have not, and offers his own statistics to substantiate this. In the New York City Cancer Institute, in the period between May, 1923 and November, 1929, there were in my service 592 carcinomata of the uterine cervix and during the same time span there were observed only 23 malignant epithelial new-growths of the vulva. This ratio between cancer of the cervix and cancer of the vulva is in approximate accord with other statistics. Why is it, that cancer of the vulva is so rare in comparison with cancer

of the cervix when these structures are scarcely less subject to obstetrical wounds at parturition?

SIGNIFICANCE OF OVARIAN FUNCTION IN CANCER INCIDENCE. Now and then it is asserted that ovarian function has a determining influence on the incidence of uterine carcinoma. If this were the case, the influence must be more remote than for any other pelvic neoplasm. If the menstruation may be taken to reflect disturbances in ovarian activity, habitual menorrhagia is characteristic in myoma of the uterus while in the case of many ovarian growths, on the contrary, an early history of hypomenses can be obtained. In cancer of the cervix however, there is usually no evidence of any prognostic upset in the early menstrual modus which is often, in the main, normal in quantity, character and duration.

NOT ALL EPITHELIUM IS EQUALLY CAPABLE OF MALIGNANT RESPONSE. Cancer is essentially a disease of the blastogenic or tissue-forming cells, and not of the formed tissue cells after they have largely lost their power of reproduction. In order to display the attribute of promiscuous proliferation, cancer must come from those cells in a given district, that even under physiological conditions respond to the call for cell-division or by which the epithelium is normally replaced. The restoration of squamous epithelium primarily takes place from the basal layer. The reproduction of gland epithelium to fill in the ranks of that which has perished subservient to its function, depends on the cell-division of prismatic cells which are not specialized or highly differentiated. At that moment when there is added to the downward growth and disruption of the regular basal layer, positive evidence of heterotopia, carcinoma is *probably* demonstrated because with the heterotopia extension and metastasis begins.

GLANDULAR AND EPIDERMOID CANCERS. The cancerous growths of the cervix are sometimes adenocarcinomata, but by all odds the greater number of cervical cancers

are epidermoid carcinomata. In a general way, it may be said that the adenocarcinoma arises from the cervical canal while the epidermoid growths spring from the exposed surface of the cervix. The provision however must be made that their origin may be anatomically ectopic when epithelium from the cervical canal has found its way to the vaginal aspect of the cervix as in erosions; or conversely when squamous epithelium has grown inward upon the lacerated and everted endocervix. More significant is the general conception that adenocarcinoma has its origin from epithelium which is capable of producing glandular structure and in very rare instances, even differentiating its cells into typical mucus secreting cells; also, on the other hand, that epidermoid cancers most likely have their genesis in the germinal layer of squamous epithelium, the Malpighian layer, the biological trend of which is to reproduce the epidermal structure when the conditions of tumor growth permit sufficient differentiation.

TYPES OF EPIDERMOID CARCINOMA. According to the dominating microscopic appearance, epidermoid carcinomata can be divided somewhat arbitrarily into three groups. The one is marked by the undifferentiated and anaplastic cells which constitute it. The other exhibits a more or less advanced differentiation of its elements and reflects plainly the epidermal characteristics in its prickle cells, epithelial pearls and keratin formation. Finally, the largest group clinically is the one which occupies an intermediate position between these two histological extremes and is identified chiefly in a negative way by the absence of notable anaplasia and the lack of pearl formation or hornification.

RELATION BETWEEN TYPES AND BIOLOGICAL MALIGNANCY. The anaplasia indicates the biologically most malignant type of epidermoid cancers; the well differentiated tumor is less active in extending and disseminating. To what extent however, in a particular individual, the biological malignancy will display itself clinically

is sometimes a different matter, for clinical experience shows that what is morphologically the same tumor does not thrive and grow in the same manner in every host. In this lies the distinction between the biological and the actual clinical malignancy manifested by a growth.

SIGNIFICANCE OF SIZE OF TUMOR CELLS. Cullen and Lubarsch correlate the small cells in tumors, with their infiltrative propensities. Very likely the actual size is less vital in this connection than their anaplastic character or biological malignancy as expressed in the rate of cell-division. When the rate of cell-division is abnormally increased many young and immature cells, which have had very little time to grow, appear in the field. With reference to the size of the parent epithelium, it is of interest that the prismatic epithelium of the cervical canal is fully twice as high as that in the uterine cavity, although adenocarcinoma of the cervix shows a decidedly greater invasive tendency than adenocarcinoma of the uterine body.

FILAR STRUCTURE OF NORMAL CELL. Fleming, in his studies of the normal cell, distinguishes a filar structure of the cytoplasm and an unorganized interfilar substance. The cilia of the tubal, uterine and endocervical epithelium are projections from the living protoplasm of these cells and may be interpreted as continuations of the filar elements. In some locations elsewhere the "cylindrical" or prismatic epithelium has a striated surface seam instead of definite cilia. The projection of the filar elements from the surface of epithelial cells in the form of fine processes appears to be a general occurrence. By special methods it has been demonstrated even in cells of the squamous layer in stratified epithelium. The well-developed filamentous intercellular connections between the polygonal cells of the dentate layer of the epidermis can probably be explained in this way. These intercellular bonds have also been found to connect the prismatic cells of the basal layer and even

penetrate the connective tissue base upon which they rest. All this suggests that after cell-division, the cells still remain in organic connection and the filar bonds continue to be unbroken. These cellular connections are more or less perfectly reproduced in cancer and probably determine whether the tumor cells extend by growing along the lymph paths in continuous chains or readily detach themselves from their fellows to become displaced by metastasis.

BOUNDARY OF NORMAL CELL. In considering the relations of the individual cell to its surroundings, the character of its boundary has no doubt an essential bearing, for the intake and the output of the cell are dependent on this. In immature or new-formed cells presumably there is no very definite limiting cell membrane; the protoplasm may be merely condensed at the periphery.

SHAPE OF CELLS. The actual shape of a particular cell is only of incidental significance. It is dependent largely on environmental pressure. If the cell were isolated, it would probably assume a round or oval shape. When the pressure comes chiefly from one direction the cells are flattened as when the cells approach the surface in squamous epithelium. Where the pressure is exerted from all sides by other cells of the same kind, the forms are apt to be polygonal as in the intermediary layer of stratified epithelium. Subjected largely to lateral pressure, the "cylindrical" or prismatic epithelium is actually polygonal or hexagonal on cross section; for this reason, the term "cylindrical" is not well chosen. The selfsame forces may influence the morphology of tumor cells but the part which they play apparently becomes the more subordinate, the greater the rapidity of the growth.

INTEREPITHELIAL SPACES. The epithelial cells are not in direct bodily contact with one another but between them are microscopic clefts or intervals, intercellular spaces, which are filled with a fluid or liquid intercellular substance. This represents partly food supply for the cell and

partly secretion and waste material from the metabolism which goes on in the cell.

In the skin it has been possible to inject these intercellular spaces through the lymph vessels of the region, which appears to show that these are in communication. In the case of single layered epithelium, superficial leakage from the intercellular clefts is prevented by a sealing of these clefts near the surface, perhaps by condensation. Important above all, as far as the relations in the cervix and vagina are concerned, is the connection of the interepithelial spaces generally with lymph paths which lead to a plexus of mucosal lymphatics and from this to a larger network which lies in a more external layer and is directly connected with the regional lymphatics and lymph nodes.

GENERAL SCHEME OF LYMPH DRAINAGE OF UTERINE CERVIX. Most of the regional lymph nodes which directly or indirectly receive the drainage from the cervix are situated centrally and distally about the bifurcation of the common iliac artery on each side of the pelvis. So there are small groups placed along the internal and external iliac arteries, also along the common iliac arteries up to their aortic origin. Another smaller group lies in the hollow of the sacrum.

The lymphatic radicles from each half of the cervix connect a meshwork of finer lymphatics in the mucous membrane with a coarser surface plexus which is partly subperitoneal. From the upper part of this surface plexus a number of lymphatics can be traced in a plane somewhat above the ureter, to the regional nodes which are aggregated about the external iliac vessel. From the middle district of this plexus, lymph vessels which are in close relation to the ureter at the base of the broad ligaments, drain into a group of nodes in the proximity of the internal iliac artery. Arising from the inferior portion of the plexus, a third bundle of lymphatics can be found in a level below the ureter and traced back between the peritoneal layers of the sacrouterine ligament behind the

rectum to the sacral lymph nodes. These relations have been carefully defined by Poirer, Cuneo and Marcille.

LYMPH DRAINAGE OF UPPER VAGINAL SEGMENT. The upper one-third of the vagina or that segment of the vagina which is in the closest relation to the cervix, has a drainage scheme which in the main points is not unlike that of the lower or vaginal portion of the cervix. The vaginal drainage on each side is directed laterally into the internal iliac lymph nodes; other lymph channels pass posteriorly and communicating with rectal lymphatics, drain into the sacral nodes. In the vagina however the plexus of fine mucosal lymphatics lies more closely beneath the epithelium and in turn this mucosal or subepithelial plexus is connected with a coarser mesh-work which lies in the submucous layer.

These considerations make it readily comprehensible how epidermoid cancer which quickly spreads from the exocervix or portio to the vaginal juncture necessarily must direct its drainage along lymph paths which run in the cellular tissue at the base of the broad ligaments laterally, and the sacrouterine ligaments posteriorly. It is also evident that the peculiar arrangement of vaginal lymphatic communications affords an explanation for the frequent occurrence of isolated or encircling secondary deposits in the vaginal mucosa.

PERMEATION OF LYMPH PATHS BY CANCER CELLS. From the impression, at first that little more than the normal resiliency and suppleness of the cellular tissue is lost, or that thin hard strands are present or definitely beaded cords which represent lymph vessels impacted with cancer cells, there may be any intermediate stage, to solid infiltration of nearly all of the cellular tissue between the broad and sacrouterine ligaments on each side with complete fixation of the uterus.

RECTOVAGINAL EXAMINATION IN ASCERTAINING CLINICAL STAGE. An early trend of epidermoid cancer of the cervix toward the sacrouterine folds will scarcely be overlooked by those who are familiar with these

important details of regional drainage. The inadequacy of the usual vaginal examination and the necessity of rectovaginal palpation for the proper investigation of the condition of the sacrouterine ligaments is apparent. At the Cancer Institute it has been the practice in the service to complete or supplement the clinical findings which were obtained on admission by a careful review under spinal analgesia while the patient is prepared for surgery or radiotherapy. No other form of anesthesia yields such complete relaxation for palpation of the pelvic organs.

SOME FACTORS IN MECHANICS OF EXTENSION. The natural linking of epithelial cells is not, at once, sacrificed when the cell becomes cancerous. How well the intercellular bridges may be reproduced in a tumor is illustrated in the typical acanthoma. When the cell becomes cancerous for whatever intrinsic reason, and asserts its autonomy by hectic cell-division, the extension of the growth occurs along the lines of least resistance.

At first the proliferating cells dissect their way with some difficulty along the narrow lymph spaces in the connective tissue until the larger radicles of the lymphatic system are approached.

The extension is in chains or columns which may be uninterrupted until the regional lymph nodes are reached. Handley has shown that this is frequently the case in cancer of the breast. Occasionally the entire subperitoneal lymphatic plexus of the uterus can be seen to be filled with closely packed cancer cells. The beaded bands, which sometimes can be felt in the sacrouterine districts on rectovaginal examination, represent extensions in continuity along the lymph paths leading to the sacral nodes.

HOW METASTASIS OCCURS. Only when the cells become detached and are set afloat in the lymph stream, does a true metastasis take place. Considered from this angle, the occurrence of metastasis is an incident, a complication in the process which obtains in malignant disease. Most

of the metastases in cervical cancer, when they do occur, are regional, but probably more frequent than is at present assumed, is the involvement of the regional adenoid masses and nodes due to direct extension.

H. Ribbert demonstrated in the connective tissue about inflammatory foci, small disseminated adenoid masses consisting of lymph-cells ensnared in a fine reticulum. Some of these had apparently developed by hyperplasia from tiny preexisting clusters of lymph-cells and others were entirely new-formed from lymph-cells which had been deposited there during the lymphostasis that accompanies the inflammation.

ROLE OF ADENOID TISSUE. Similar adenoid masses are found in the outskirts of cancerous growths. These are either newly formed, or incited to increase in size through hyperplasia, by the action of certain products which emanate in the primary growth and escape into the lymph current, or by some transferred tumor cells which have been destroyed. Such masses of adenoid tissue may intercept detached cancer cells and harbor them, and, in a sense, determine the location of small metastatic deposits. The difficulty of eradicating all these foci in the course of operation for cancer explains the frequency of recurrence. Fortunately the growth of implanted cancer cells is not fostered by lymphoid tissue. Because of the congenial environment, the cancer cells may remain dormant for the time being or perish. Cancer of the uterus has reappeared as late as fifteen years after operation. This seems to show that the proliferating activity may be held in check for long periods without necessarily destroying the ectopic epithelial cells.

PART PLAYED BY REGIONAL LYMPH NODES. On the whole, the anatomical conditions that obtain in the lymph nodes are conducive to lymph stasis. A number of larger ingoing lymphatics break up into wide intercommunicating capillaries which surround both the cortical and medullary aggregations of adenoid tissue that constitute the lymph node. A fine reticulum

supports the lymph capillaries and adenoid masses. This has its origin from numerous fibrous processes or trabeculae which are derived from the capsule of fibrous connective tissue that surrounds the lymph node and septa which penetrate its interior.

The outgoing lymphatics in which the lymph is again collected, are of smaller caliber and fewer in number than those which enter the node. The lymph capillaries or sinuses are disproportionately wide and sacculated and crowded with escaping lymphocytes. It is not difficult to see what happens when a cancer embolus drifts into these surroundings. According to Ribbert, cancer cells are at first lodged in the peripheral lymph sinuses of the node and partly or completely surround the cortical adenoid masses. Gradually the deeper portions are involved, until the adenoid tissue is completely replaced by cancer.

The cortical adenoid masses of the nodes contain the main germinal centers in which the multiplication of lymphocytes takes place; while the relative infrequency of mitotic figures indicates that there is but little germinal activity in the medullary portions. It seems likely, and this tallies with the behavior in inflammatory disease but is difficult to prove, that products or cells arising from the primary growth initially irritate the regional lymph nodes sufficiently to induce a catarrhal desquamation of the endothelium of the lymph sinuses and call for an increased production of lymphocytes in the germinal area with lymphocytosis and hyperplasia. At any rate, these are the changes that seem to antedate the visible embolic lodgement of cancer cells. Fundamentally the new environment of the alien cells is not favorable to their growth. If this were the case, metastatic growths at the site of the regional lymph nodes would be a common occurrence. Instead, limiting fibrosis with encapsulation of the tumor cells is the not infrequent outcome.

CANCER BED. The area from which the cancer originally grows is conveniently called the cancer bed. Radiotherapy, in

order to be effective, must be directed toward this area rather than to the exophytic mass that may have arisen from the germinating tumor base. Particularly is this vital if any result is to be achieved when radon seeds are used.

TUMOR DEGENERATION AND INFECTION. The decadent portions of the tumor are significant only because they become invaded by putrefactive and pathogenic organisms and give rise to ulceration, excavation, crater-formation, bleeding, and discharge. The toxemia which is due to local infection and not to products of the tumor itself is often the chief factor in the patient's invalidism. As soon as the local asepsis is more or less perfectly restored, a relative measure of well-being returns.

A blocking of the cervical canal by the exophytic cancer masses may lead to pyometra. Rarely the distended uterus reaches the size of a cocoanut. When this occurs in women after fifty, the constitutional disturbance may be very slight; frequently the temperature is scarcely elevated although when a dressing forceps is introduced, a large quantity of pus escapes and the tumor, which was palpated in the hypogastrium, disappears.

In general it may be assumed that, as soon as the surface of a growth is broken, the tumor tissue becomes invaded by bacteria. Putrefactive bacteria play a large part and give rise to some general intoxication. Much more menacing however are the pathogenic organisms, the staphylococci and streptococci. It is the streptococcus particularly that permeates, and seeks the lymph paths of the parametrium. A rise of temperature, local pain and tenderness in such an instance plainly indicate that an active septic parametritis exists and that surgical or radiological measures must be postponed.

CLINICAL PECULIARITIES OF ADENOCARCINOMA. An adenocarcinoma which starts in the cervical canal characteristically remains within the confines of the external os, although it may have progressed to such an extent that the disintegrating

tumor has completely excavated the cervix leaving only a thin shell of the exocervix. Even then very little change in the surface appearance of the cervix may be evident excepting a slight irregularity in the outline of the external os. The presence of the tumor is established beyond doubt when the probe no longer discerns the smooth cervical canal, but in its place a cavity with crumbling, readily bleeding walls. While encroachment upon the squamous covering of the portio is so strikingly avoided by the glandular carcinoma, it may even extend upward beyond the internal os into the lower uterine segment and show metastatic deposits in the cavity of the uterus.

CLINICAL CHARACTERISTICS OF EPIDERMMOID CANCER. The cervical cancers which are usually seen are of the epidermoid type, and springing from the stratified epithelium exhibit a tendency to follow this epithelium beyond the confines of the exocervix along the fornix into the vagina. Even after much destruction, the epidermoid cancer does not quickly pass the barrier of the internal os and metastatic deposits, as a rule, are not found in the uterus.

SPECULUM PICTURE OF EPIDERMMOID CANCER. In the everyday routine, most of the cervical carcinomata that can be viewed directly by means of the vaginal speculum are epidermoid in character. There may be a dark or dusky red patch with a raspberry surface which bleeds easily on contact, or a larger exophytic mass projecting as a cauliflower-shaped growth. The tumor surface may have broken down and a greyish, greenish or blackish slough gives rise to a characteristic malodorous discharge.

VAGINAL INVOLVEMENT. The destruction then involves most of the vaginal portion of the cervix leaving a crater-like pit with an elevated brim which is not a part of the cervix but is formed by the encircling invasion of the vagina. Sometimes other crescentic or completely annular vaginal deposits occur two or three centimeters distant from the crater edge,

while the intervening segment of vagina retains its normal suppleness to palpation. Again, isolated deposits may be found in any part of the vaginal wall. These secondary aggregations involve the mucous membrane and are probably due to metastasis by tumor cells which have found their way to the subepithelial lymphatics. Their permanent disappearance after the implantation of radon seeds and the absence of new aggregations in their immediate vicinity emphasizes the impression that they are often truly metastatic.

If the distance of the advancing crater edge from the introitus is recorded from time to time, the rate of vaginal invasion can be established. It is found ordinarily that the progression is most rapid along the anterior vaginal wall. When the status is taken, the distances are estimated digitally at the four cardinal points and the numbers dictated, for convenience, in a clockwise order. Enlargement of the *pubic* lymph node, as it may be called, is observed only when the invasion has reached the vaginal outlet. The *pubic* node is one of the inguinal lymph nodes and lies in the inguinal region close to the pubic spine.

IMPLICATION OF BLADDER AND URETHRA. As the neoplastic disease advances, the vesical wall becomes infiltrated by direct extension of the primary growth in the cervix and metastatic deposits occur in the submucous layer. Notwithstanding the fact that the bladder is closely attached to the cervix just below the peritoneal recess of the anterior cul-de-sac, clinically speaking it is not seriously involved until the carcinoma has made considerable headway along the anterior vaginal wall. Invasion of the urethra rarely leads to actual blocking which requires intervention. A vesicovaginal fistula forms only in about one-half of the advanced cervical carcinomata. The others succumb to the adjuncts of the neoplastic disease before this complication results. Sometimes it seems that the coexistence of tertiary syphilis exerts a favorable rather than an unfavorable influence as far as local sclerosis is con-

cerned. At least, in two such instances at the Cancer Institute the connective tissue response was certainly unusual. In one, locally the advance of the cancer seemed actually arrested and an existing vesicovaginal fistula about 2 by 3 cm. in size was converted by fibrosis into an oval communication with a white hard, smooth border. Nevertheless it may be that this behavior was, after all, coincident and not etiologically related.

HYDROURETER, HYDRONEPHROSIS, CHRONIC NEPHRITIS, UREMIA. The ureter can be completely imbedded, as it were, in a lava of cancer, while its muscle coat still resists perforation. The obstruction which so frequently occurs seems to be due to compression from cancerous infiltration and supervening swelling from secondary inflammation with edema and exudate. Dilatation of the ureter, hydroureter, and hydronephrosis, chronic nephritis with gradual suppression of the renal function constitute the sequence which leads to chronic uremia and is the most common immediate cause of death. The euthanasia of the terminal stage is largely due to the uremic poisoning.

BOWEL INVOLVEMENT AND RECTOVAGINAL FISTULA. Fistula of the posterior vaginal wall does not occur as readily as anteriorly. This is explained by the tardier invasion of the posterior wall and the fact that it may be involved to the extent of 2 or 3 cm. before the lower angle of the posterior peritoneal cul-de-sac is reached where the vagina is contiguous with the rectum. The altered surface of the rectal mucosa and its attachment to the invading tumor can be detected weeks before the fistula actually forms. Not infrequently the growth encroaches upon the lumen of the rectum carrying mucosa in front of it and causing a partial obstruction of the colon. The site of predilection is usually near the rectosigmoid angle. Seldom is the obstruction so complete that the bowel cannot be emptied by means of the rectal tube. So greatly lowered is the vitality of these unfortunates that the outcome, even of a simple colos-

tomy under local or spinal anesthesia, is doubtful.

THREE CLINICAL STAGES OF CERVICAL CANCER. It is customary to assign patients suffering from cervical cancer to groups according to the clinical stage of the neoplastic disease. To the first group belong those in whom the carcinoma is still confined to the cervix; in the second group are those in whom the tumor is beginning to transgress the limits of the cervix and either invades the parametrium and the cervicovaginal juncture as in epidermoid growths, or the parametrium and the internal os as in glandular carcinoma. The third group embraces all the patients with advanced neoplastic disease and it is specified, in addition, when a vesicovaginal or rectovaginal fistula exists.

INVASION OF PARAMETRIUM. Unlike carcinoma of the body of the uterus, the invasion of the parametrium occurs along the base of the broad ligaments while its free border which contains the fallopian tube and related structures remains relatively free of involvement. In the undifferentiated, anaplastic types the invasion is prompt while in the well-differentiated types of cervical cancer the broad ligaments may exceptionally give no palpable evidence as late as six months after the tumor incidence. In this respect the plexiform type together with the glandular carcinoma occupy an intermediate position. In these considerations it makes a decided difference whether the neoplastic disease appears in the decades before or after the age of fifty. With menopausal involution, the pelvic lymphatics become atrophied and to a varied extent the passage of the cancer cell is impeded. Potentially, senility creates a situation similar to that which is induced by high voltage x-ray therapy although the tissue process is histologically different.

EDEMA OF VULVA AND LOWER EXTREMITY. The pathways of invasion are determined, to a large extent, by the anatomical lines along which the regional lymph drainage takes place, the spread of the

neoplastic disease is both lateral between the layers of the broad ligament and posterior along the sacrouterine folds. Eventually the ligamentous anchorage of the cervix, through one or more of these ligaments, become rigid and the primary tumor site, which is usually converted into a discharging crater, is fixed in the pelvis as the process extends along the cellular tissue to the pelvic wall. Edema of the vulva and lower extremity is likely to indicate this advanced stage, when the return flow in the iliac veins is impeded by cancerous nodes near the bifurcation.

NERVES INVOLVED. At the same time, the lymphatic sheaths of nerve trunks may be extensively invaded and atrophy of the medullary sheaths and obliteration of the axis cylinders is caused by pressure. Persistent pain is complained of in the gluteal region and back of the thigh and this may make walking difficult.

DISSEMINATION OF CANCER THROUGH BLOOD CHANNELS. Unlike sarcoma it is not characteristic of carcinoma to invade blood channels. This occurrence in cancer of the uterine cervix is often a late complication. In some instances it seems that this sequel is invited particularly when there is marked secondary involvement of the rectum. Through the hemorrhoidal plexus of veins which surround the lower portion of the rectum, a direct connection is established between the portal and systemic venous systems. If, incident upon the formation of a rectovaginal fistula, the hemorrhoidal plexus is eroded and a cancer embolus gains access here, there are two anatomic paths which the embolus may follow.

Picked up by its superior hemorrhoidal branches, the inferior mesenteric vein carries the embolus into the splenic and thence into the portal vein to the liver.

Otherwise, the internal iliac vein is reached from its middle and inferior hemorrhoidal radicles and the detached cancer cells are delivered by way of the common iliac to the inferior vena cava,

the right heart, and finally lodged in the pulmonary arterioles.

The vaginal plexus of veins which communicates with the vesical plexus in front and the hemorrhoidal behind, is chiefly concerned where the posterior involvement is less extensive, as is the rule, and fistula formation occurs anteriorly. In this situation portal metastasis, anatomically considered, is less likely than systemic.

When the vaginal invasion is not a factor, as in glandular carcinoma of the cervix, hematogenous metastasis comes through the uterine plexus and therefore tends to have its destination in the lungs.

In the main points, autopsy has confirmed the general impressions obtained from anatomical and clinical considerations that have to do with the reason why such metastases occur and what determines their localization.

CANCER THROMBUS AND EMBOLUS. According to M. Schmidt, carcinoma may penetrate a blood vessel by way of the perivascular lymphatics. Fibrin is deposited and a thrombus forms at the site of penetration. The thrombus may go on to organization and fibrosis and the entangled cancer cells may be destroyed. When however cancer cells gain a foothold on the wall and grow within the vein, they produce endophytic projections into the lumen.

These grow to a greater or lesser extent until they become detached and are carried along the blood stream.

It appears that only a small number of the tumor emboli that are implanted in the pulmonary arterioles eventually prove to be the source of secondary growths in the lungs. Thrombus formation with organization and incarceration of the cancer cells, Schmidt concludes, is a frequent outcome although the malignant epithelium may remain viable and under proper conditions give rise to late metastases.

SKELETAL METASTASIS. In the skeletal system, metastasis is so unusual in cervical cancer, that its radiographic demonstration calls for a critical review of the primary source. In one instance in which a large metastatic deposit was detected in the head of the humerus, the cervix involvement on admission closely resembled a carcinoma but was afterward interpreted both histologically and clinically as a chorioepithelioma.

The intensive study of cancer of the uterine cervix opens many new lines along which useful observations can be made. Some of these problems also have a larger significance in the general understanding of cancer. With this in mind, a better correlation must be sought between the biological and the clinical.

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OPEN COMMUNICATION BETWEEN APPENDICEAL MUCOCELE & CECUM*

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THE conception of the pathogenesis of localized or diffuse distention of the appendix by thick gelatinous mucoid material has practically always presupposed complete or almost complete occlusion of the lumen proximal to the dilated portion, absence of pathogenic organisms, and an actively secreting mucosa. In most cases reported no mention is made as regards the patency of the proximal portion of the organ and attention has been concentrated upon the method of escape of the jelly-like liquid into the abdomen, and its relation to pseudomyxoma peritonei.

That a mucocele can form without complete occlusion at the proximal end is proved by Vorhaus who described the process in a forty-six-year-old woman giving a history of several attacks of pain and a small palpable mass in the right lower abdominal quadrant which upon several occasions showed an irregularly barium-filled appendix that proved to be, at operation, a mucocele 12 cm. in length and 5.5 cm. in circumference, involving the appendix and lower cecum. Although there is no detailed pathological report, it must be assumed that the lumen may have been closed at times but that the obstruction subsided in order to admit the barium. Dodge, in recording a study of 142 cases found that in 37 the lumen was studied, and in 5 of these the lumen was closed or partially closed.

The case to be reported exemplifies the patency of the proximal portion of the appendix as visualized on fluoroscopic and pathologic examination of the removed

organ. The history elicits repeated exacerbations of an inflammatory process.

A white female, aged twenty-five years, married three years, was admitted to the hospital March 27, 1930, with the following:

History. Seven months before entering the hospital she suffered her first attack of cramping pain in the periumbilical region. In two hours this became more and more severe and gradually localized to the right lower quadrant of the abdomen. This was accompanied by nausea and vomiting on three occasions, and some fever. In the course of three days with application of an ice bag and rest in bed these symptoms subsided. Following this the patient had constant abdominal "soreness" which was most marked on the right side and occasionally became sharp but did not radiate to any other part of the abdomen. In December of 1929, three months after the onset of clinical manifestations, she experienced a similar seizure of abdominal discomfort; however, on this occasion it was more severe in the epigastrium and radiated to the right shoulder and scapula but was not accompanied by vomiting. These symptoms led another physician to regard the entire picture as the result of a diseased process of the gall bladder. Following this, until her entrance, there was more or less continuous epigastric discomfort, repeated belching unrelated to the ingestion of food, rather marked constipation, and a loss of about 10 lb. in weight.

The history referable to the pelvic organs did not point to any lesion to account for the complaints in the right lower abdominal quadrant. However, she had had a forceps delivery, of a normal infant, fourteen months previous accompanied by a laceration of the perineum which was sutured at the time. The post-partum course was afebrile. Her menstrual periods were regular and of five days' duration

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until three months before operation but from that time she bled every three weeks, for seven days and passed small clots of blood but had no pain.

Eating, urinating, or defecating had no relation to the pain.

Physical Examination. The patient was apparently emaciated, weighing only 97 lb., and presented a sallow pale brown appearance of the skin. The essential findings were confined to the abdomen. The abdominal wall was 2 to 3 fingers below the level of the chest and the anterior wall was soft in all areas. The cecum and sigmoid were palpable and tender and lateral traction in the former region resulted in pain at the site which also radiated towards the umbilicus. The edge of the right hepatic lobe was felt 2 fingers below the right costal edge and was slightly tender. She offered no complaints on pressure in the region of the gall bladder. The lower one-third of the right kidney could be felt on deep inspiration.

Bimanual pelvic examination demonstrated a slight bilateral healed laceration of the cervix. The corpus uteri was small, in axial position, and the appendages were free from any palpable pathological changes.

The urine was devoid of any pathological findings, there were 8750 white blood cells per cubic millimeter and the differential count showed 75 per cent polymorphonuclear leucocytes.

Fluoroscopic examination of the gastrointestinal tract revealed the fundus of the stomach in the pelvis and contained 15 per cent residue at the five hour examination. The duodenal cap was spastic but showed no constant deformity. The colon was also in a clonic state. *On fluoroscopic examination, the appendix was visible, tender, and fixed behind the cecum.* Plates confirmed these findings except that the appendix was not visualized because of its retrocecal position.

Operation March 31, 1930. Through a right rectus incision exploration of the upper abdomen revealed no abnormality of the gall bladder, liver, or stomach. A freely movable cecum covered by a Jacksonian membrane was delivered. The appendix was curled around the lower posterior portion of the cecum and its midportion slightly kinked by moderately firm fibrous adhesions extending from the cecum to the mesoappendix. Similar adhesions extended from the distal 2 cm. of the appen-

dix as a pyramid-shaped structure with its base formed by a 2 by 3 cm. area of a high loop of the ileum. Between these thin bands were 2 cyst-like structures arising from the end of appendix, the largest of which was 1.5 cm. in diameter and the other about 8 mm. across. In dividing the connective tissue strands the cysts were broken discharging a thick, jelly-like, colloid liquid. After the adhesions were freed the slightly bleeding denuded area of the ileum was sutured over. The mesoappendix, after the adhesions were cut, was clamped and ligated. The appendiceal base was crushed, including part of the cecum, ligated and dropped. The pelvic organs were free from any abnormal changes. No jelly-like material was found free in the abdomen.

Pathologically, the appendix measured 6.5 cm. from its base to the tip and the diameter varied from 1 cm. across the base and 1.2 cm. at the tip which was slightly bulbous. On the antimesenteric border there was a bulbous swelling 2 cm. in the long axis of the organ, protruding as high as 9 mm. above the serosa, and having a transverse diameter of 7 mm. The terminal portion of this tumefaction had its distal end 2 cm. from the tip of the appendix. The surface was slightly lobulated and of a gray glistening color which was interrupted by very thin hyperemic fibrous adhesions. The serous surface of the appendix and mesoappendix were the site of similar adhesions.

Transverse sections through the appendix at various levels between the base and the proximal portion of swelling on the anti-mesenteric border revealed a patent lumen, 2 to 4 mm. in diameter, which was free from any material of any nature. Surrounding the cavity the mucosa was of normal appearance, and below it were 7 to 8 large discrete and occasionally confluent lymph follicles. In the submucosa were focal patches of fibrosis and spaces filled by fat. The circular muscle fibers were occasionally encroached upon by these and here and there were scattered lymphocytes. The layer of longitudinal muscle fibers were of normal histological appearance. The serosa in places presented a vacuolated appearance in which were small accumulations of basophilic homogeneous material. About these spaces was a fibrillar network enmeshed in which were many varying sized capillaries about which were occasional small accumulations of lymphocytes.

Transverse sections through the site of the tumefaction revealed the picture seen in Figure 1, demonstrating a narrow, then wider tract

At the site of the defect, or hiatus, the epithelium extended well out to line the proximal portion of the mucin-filled cavity, and below



FIG. 1. Antimesenteric appendiceal mural defect leading into mucocoele, contents of which give positive microchemical reactions for mucin.

penetrating the wall on the antimesenteric side of the appendix which leads into a space filled by material that gave positive microchemical reactions for mucin. The intact portion of the appendix was lined by columnar epithelium which, only here and there, dipped down a slight distance. The submucosa was markedly thickened by dense layers of eosinophilic leucocytes, polymorphonuclear leucocytes, lymphocytes, and a thin fibrillar connective tissue network, and a few isolated glands. Irregular and poorly defined masses of lymphocytes and extensive hyalinized areas resulted in marked thickening of the submucosa. The circular muscle fibers were separated in places by similar inflammatory cells as seen immediately below the epithelium lining the cavity. The longitudinal muscle layer was moderately thickened and below the serosa was an isolated group of lymphocytes. The lumen at this level contained no mucus.

this was the same inflammatory exudate as seen in the intact portion. The muscular walls extended part way out to make up part of the wall of the cyst; however, in these portions considerable hyalinization and fragmentation had taken place. The cavity of the cyst proper was filled by homogeneous pale blue staining material (hematoxylin and eosin) which was interrupted by varying sized and shaped masses of lymphocytes and occasional plasma cells and erythrocytes which were most abundant on the appendiceal side of the cavity, next to the jutting out muscular layers of the appendix (see Fig. 2). The wall of the distal portion of the cavity was composed of markedly thinned out fibers containing elongated slightly pycnotic nuclei.

Discussion. By correlation of the history and the pathological findings we are led to assume that the patient suffered gradual

perforation of the appendiceal wall over a period of seven months, with accompanying subacute exacerbations, with referred

in a diffuse or localized dilatation of the organ. In our patient, it is possible that the appendix may have been occluded at



FIG. 2. Wall of mucocoele close to appendix. Cavity contains mucin and groups of lymphocytes and plasma cells latter forming a layer internal to connective-tissue wall.

pain into the upper abdomen and gastric symptoms. The site of perforation is typical of mucocoeles following an inflammatory process rather than a congenital defect. In the latter state the defect is attributed to apertures in the wall about the vessels entering on the mesenteric side. The other theories favoring a congenital pathogenesis apply as well to an inflammatory process, in that separation of the muscle fibers and weakness of the musculature do occur with an inflammatory process. As to whether an ulceration or an intramural abscess was present with the onset or in the course of the disease, it is impossible to say at this stage of the condition.

If the lumen of the proximal portion of the appendix is occluded it is reasonable to assume that the secretory pressure of the residual intact mucosa is sufficient to result

some time earlier in the process. However, this is hard to believe because intermittent occluding spasm of the appendix would be almost impossible in view of the amount of fibrosis of the wall and the changes in the muscular layers. Also, the specimen shows no evidences of mucus in the lumen proximal to the mucocoele indicating that the fluid had not regurgitated into the cecum from the possible previously distended portion. In addition the degree of submucosal fibrosis distal to the base would tend to prevent dilatation of this region.

It has been assumed that the contents of a mucocoele is sterile as otherwise gangrene or empyema of the appendix would result. In our patient the contents of the appendix and the cavity of the mucocoele had access to the cecal portion of the large

bowel and therefore the ordinary intestinal bacterial flora could have reached the peritoneal cavity, by way of the gap in the lumen, and resulted in generalized peritonitis. The absence of peritonitis is hard to explain unless the mucosa or mucus had bactericidal properties or the quantity of infected material was of such a small amount that the peritoneum could overcome this infection.

The end-result at times has been the typical picture of pseudomyxoma peritonei in which the entire abdominal cavity becomes filled by this thick material. This condition has been attributed to the secretory property of the peritoneum or to actively secreting epithelial cells freed from their primary seat and continuing their function of producing mucus. In no other form of peritoneal irritation does the abdominal cavity lining respond in this manner. Histological examination of the jelly-like nodules attached to the peritoneum shows that they are superimposed on this structure rather than part of it so that this explanation is hardly tenable. Although examination of this fluid has, in some instances, revealed the presence of isolated and occasionally short rows of epithelial cells after very careful and extensive searching, certainly this small number of infrequently found cells could give rise to no such enormous accumulation of intra-abdominal mucoid material.

The theory has also been advanced that the fluid is not a product of epithelial secretion but rather a mucoid degeneration of newly formed connective tissue at the site of the mucocele. This may explain the presence of a small amount but it is hardly possible that this can account for the tremendous amounts seen in some instances.

It seems more logical to conclude that the primary focus is in the secreting epithelium of the ovary, enterocystoma, or appendix. For if these offending foci are removed, providing that they are not associated with a carcinomatous process, or if not too extensive, and keeping in mind the

possibility of their arising from two sources, then the process usually stops. This is well exemplified in the 2 cases reported by Ries. Both patients have recently been examined and show no evidences of reaccumulation of the fluid. The first, in 1907, had a head-sized pseudomucinous cystoma of the ovary and an appendix, the site of a mucocele, removed. Large quantities of colloid material escaped when the peritoneum was opened and as much of it as possible were scooped out of the abdominal cavity. The second patient operated on in 1923 had the omentum covered by colloid which was found to be escaping from a large cystic tumor of the right ovary and a similar but smaller and intact mass was found in the left ovary and the cul de sac was filled by jelly-like material.

CONCLUSIONS

From roentgenological and pathological evidence permanent stenosis of the appendix is not necessary for the formation of a mucocele.

Pathogenic organisms may have access to a mucocele but do not necessarily result in peritonitis, empyema, or gangrene of the organ.

The bactericidal properties of the mucus or pseudomucinous material and the epithelium of the appendix deserve further study.

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INTRA-ABDOMINAL USE OF EPINEPHRINE IN HYPOTENSION DURING SPINAL ANESTHESIA*

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THE fall of blood pressure during spinal anesthesia is caused by: (1) Dilatation of the splanchnic vessels, and (2) An abrupt block of the secretory impulses to the suprarenal medulla, with a resulting oligoadrenalemia.

The vasoconstrictors of the splanchnic vessels and the secretory nerves of the suprarenal medulla are both sympathetic fibers. They have a medullated preganglionic part, emerging from the spinal cord with the anterior motor roots of the spinal nerves, pass the paravertebral ganglia with the white rami communicantes and run into the collateral semilunar or solar and the superior mesenteric ganglia. Here they make a synaptic connection with the non-medullated postganglionic fibers which run to the blood vessels and abdominal viscera. From the sixth lower dorsal and from the upper third and fourth lumbar segments collected preganglionic sympathetic fibers form the major and minor splanchnic nerves.

In spinal anesthesia the subarachnoid part of the preganglionic sympathetic fibers are blocked with the anterior motor roots and no stimulus can reach either the synapse in the collateral ganglia or the arborization of the postganglionic fibers. The vessels of the stomach, the intestines, the kidneys and spleen are cut off from the vasomotor impulses and become dilated. At the same time all the secretory stimuli to the suprarenal medulla are blocked and the adrenalin output of these organs is stopped or greatly reduced. A drop in blood pressure results from these combined effects of the sympathetic block. The fact that various individuals possess splanchnic vessels of different capacities may account

for a variation in blood pressure drop with the same height of anesthesia. The presence of accessory chromaffin tissues in the organismus may cause a still further variation.

(Preanesthetic hypertensions of various origins are excluded from these considerations.)

A sudden fall in blood pressure is no longer regarded with the old anxiety. Most surgeons disregard it entirely and many do not bother with blood pressure readings at all. However three factors should be considered in the matter of anesthesia:

1. A proper blood supply to the heart chambers.

2. That the pulmonary vessels have sufficient circulation to oxygenize the blood.

3. A satisfactory blood supply to the brain so that the vital centers of the medulla oblongata can be adequately nourished.

As long as these three factors are properly maintained there need be no alarm. In the Trendelenburg position the dreaded consequences of an empty heart, insufficient oxygenation of the blood and of cerebral anemia are eliminated. In the Trendelenburg position sufficient blood will be drained by the vena cava inferior to supply the right auricle of the heart, and if the anesthesia proceeds to the third or second dorsal segment it will not be unfavorable to heart action. The heart receives its sympathetic accelerator fibers chiefly from these segments and if they are affected the cardio-depressor vagus fibers invariably will produce slower contractions with a prolonged diastole. A longer diastole means better filling of the chambers and a longer rest for the myo-

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cardium, which will be followed by a more powerful systole. This cannot be interpreted as evidence of insufficient cardiac function.

In considering these physiological facts and finding confirmation in many clinical observations, we cannot blame surgeons for being optimistic, or of being indifferent toward temporary hypotension in spinal anesthesia.

The experimental work coupled with many clinical observations by Koster¹ shows clearly that the fear of respiratory paralysis in spinal anesthesia is caused chiefly by false physiological interpretations and by misunderstanding. He proved that all of these symptoms are caused by secondary cerebral anemia. Recently Saklad² in his paper disproved the shock producing reputation of spinal anesthesia.

All seem to agree on one point, namely, that the Trendelenburg position is the best method of overcoming difficulties which may arise from spinal anesthesia. I am of the same opinion but with one exception: that the Trendelenburg position is reliable only as long as the patient is in the dorsal position. In the dorsal position the vena cava inferior occupies the deepest part of the abdominal cavity. According to the law of gravity it will drain the blood from the dilated splanchnic vessels. But if in spinal anesthesia, we place the patient in the ventral position, with head lowered, as is sometimes necessary for certain operations, we may be surprised by disagreeable incidents.

In this position the vena cava inferior will occupy the highest plane of the abdominal cavity and the drainage of blood from its branches is not so facilitated by gravity, and consequently it receives and transmits less blood to the right auricle. Then also there is interference with thoracic respiratory movements and, as we know,

the rôle of the chest is very important when, in expansion, it "sucks" up the blood from the large veins. Respiratory embarrassment with cerebral anemia may suddenly appear, and in this case the old reliable Trendelenburg position will not help unless the patient is turned on his back. This should be done before the patient's condition is too grave, and artificial respiration should be started at once.

We confess that the Trendelenburg position is far more useful than any procedure or medication at our disposal in combating the undesirable by-effects of spinal anesthesia.

With our present drug armamentarium we are far less successful. Let us suppose a patient under spinal anesthesia and in Trendelenburg position and that we cannot obtain the blood pressure at all. The pulse rate is increasing: it is flying, and we would like to correct this condition. What can we do? We have two drugs at our disposal to avert or correct the fall of blood pressure. These are ephedrine and epinephrine.

EPHEDRINE

Preanesthetic injections of ephedrine are strongly advocated by many and ridiculed by others. Ephedrine stimulates the vasomotor center, the heart action and peripherally acts directly on the muscle tissue instead of on the myoneural junction of the sympathetic fibers.¹ In many surgeons' minds there is no doubt about the value of ephedrine injections, ten to twenty-five minutes before spinal anesthesia is administered. Falls of blood pressure are not so frequent and alarming. Nevertheless we see them in spite of ephedrine. During anesthesia a second injection may raise the blood pressure, or it may not. Labat, Saklad and others have protested against repeated ephedrine injections during spinal anesthesia on the grounds that ephedrine does not produce a vasocontraction in the

¹Koster, H. Spinal anaesthesia for head, neck and thorax: Relation to respiratory paralysis in spinal anaesthesia for the head, neck and thorax. *Surg., Gynec. and Obst.*, 149: 617, 1929.

²Saklad, M. Studies in spinal anesthesia. *AM. J. SURG.*, 11: 452, 1931.

¹De Edds and Butt. Further evidences of non-symphathomimetic action of ephedrine. *Proc. Soc. Exper. Biol. & Med.*, 24: 800, 1927.

splanchnic vessels but does so in the rest of the vascular system, with a resulting pooling of more blood in the already dilated splanchnic system. As an illustration of the prevailing opinion among investigators I quote Saklad who gave an excellent analysis on the basis of experimental and clinical studies of Chen, Bloedorn-Dickens, Size, Blalock, Rudolph-Graham, Phelps and himself. He found that spinal anesthesia administered to dogs after the injection of ephedrine caused vasodilatation. Administration of ephedrine under spinal anesthesia produced no vasoconstriction in the splanchnic vessels. He summarizes:

We have in ephedrine a powerful drug which through its vasoconstricting action and by its cardiac stimulation is capable of raising blood pressure. It is an agent, which is contraindicated in cases of cardiac insufficiency. It may cause ventricular extrasystoles and in cases of chronic myocarditis its use is apt to cause a fall in blood pressure rather than a rise. It should not be given in small doses in the presence of low blood pressure. In large doses it puts too heavy a load on the heart. It is of no value in severe shock. Its dosage must not be repeated. [In his clinical observations he admits that] the administration of ephedrine does not allow the pressure to fall to the extent that would occur if it were not used.

He found the average drop of blood pressure to be 38 mm. in cases where ephedrine was used before the spinal and 60 mm. average fall where no ephedrine was used.

I have a series of 150 spinal anesthesia cases in which spinocaine was used and in these I administered 0.025 to 0.05 cg. of ephedrine subcutaneously prior to the spinal injection. In these unselected cases the anesthesia reached the costal margin in 87 per cent and the average fall of blood pressure was 24.5 mm. In 112 cases in which the preoperative systolic blood pressure did not exceed 140 mm. the average fall was only 17.2 mm. Among the cases which received ephedrine injections during the established anesthesia for the purpose of checking blood pressure drops, 37 per cent did not respond with a rise.

The remaining number showed an average increase of 15 mm. within fifteen minutes. The majority of these cases showed an increased pulse rate after the ephedrine injections.

EPINEPHRINE

The action of this drug is identical with the function of the sympathetic nervous system. Its point of attack appears to be in the muscular or glandular tissues innervated by the sympathetic. One of its important actions (among many others) is the vasoconstricting effect on the splanchnic vessels. The general opinion among research workers is, that adrenalin is released slowly by the suprarenal medulla and it is proved that this output is stopped or greatly reduced by section of the splanchnic nerve supply. In spinal anesthesia there may be a complete block of the secretory fibers which supply the suprarenal medulla. We are justified in supposing, therefore, that because of this interference in normal adrenalin output, oligoadrenalism results. The extract of suprarenal medulla either from natural sources or its synthetic equivalents, is used in 1-1000 solution to combat hypotension. The solution is administered subcutaneously, intramuscularly or, in emergencies, intravenously. It is reliable, prompt and powerful when given in time and into the blood stream. The blood pressure rises and the ventricular contractions are pronounced. However, in a few minutes its beneficial effects are over and herein lies its weakness. It is too easily oxydized and destroyed. Subcutaneous and intramuscular injections produce a longer effect but the slow absorption when so used would, in an emergency, prove too costly. Repeated injections of epinephrine in cases with heart lesions or with arteriosclerosis are not desirable.

Epinephrine solutions, even very dilute, still exert a pronounced vasoconstrictor action when locally applied. In abdominal operations we can take advantage of this factor and as we have easy access to the

splanchnic region we have a method of dealing with undesired vasodilatation. In an emergency during abdominal operation, where there is a disappearance of blood pressure combined with a weak and flying pulse and eventual respiratory embarrassment, I recommend the following mode of epinephrine medication:

The patient receives immediately an intravenous injection of 0.5 c.c. of 1:1000 epinephrine solution. Simultaneously from 8 to 15 drops of sterile epinephrine solution, diluted with 100 c.c. of sterile normal saline solution are poured into the peritoneal cavity. The intravenous injection acts promptly and the intra-abdominally administered solution will maintain the effect by its prolonged vasoconstrictor action over the dilated splanchnic vessel area. This method works instantly and for from fifteen to sixty minutes there is a definite vasoconstrictor action just at the point at which the blood stagnation is greatest. Sterile Erlenmeyer flasks with prepared normal saline solution should be kept in readiness. The epinephrine solution is made in a few seconds and it can be used any time between opening and closing of

the peritoneal cavity, should the condition of the patient require this medication.

CONCLUSIONS

1. In analyzing the innervation and function of the suprarenal gland and the condition begot through spinal anesthesia it is justifiable to believe that oligoadrenalemia is also a factor in the development of hypotension.

2. The Trendelenburg position is the most effective method of combating an insufficient blood supply of the heart chambers, insufficient external respiration and cerebral anemia; but precaution should be used in the ventral Trendelenburg position.

3. During abdominal operations under spinal anesthesia and in the presence of alarming circulatory disturbances, the intra-abdominal administration of 8 to 15 drops of epinephrine in 100 c.c. of normal saline solution is a useful method to support the simultaneous injection of intravenous epinephrine solution. This method has a limited field. In pus cases it should be avoided, or if used, proper precautions must be taken not to disseminate infection.



THE DETMOLD METHOD OF CONTROLLING INOPERABLE HEMORRHAGE

A FORGOTTEN, BUT OCCASIONALLY INVALUABLE, PROCEDURE*

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DR. WILLIAM L. DETMOLD (1808–1894), Professor of Military Surgery and Hygiene during the Civil War in the College of Physicians and Surgeons of New York, in a paper published in the *American Medical Times*, of January 3, 1863, discussed gunshot wounds of the lungs, and suggested a treatment to check hemorrhage which was later referred to in Holmes' "System of Surgery."¹ It should be remembered that at this time the recognized procedure to control profuse hemorrhage was liberal phlebotomy, this treatment being based on the idea that after large loss of blood, the blood pressure being diminished and the clotting element of the blood increased, nature would check the bleeding.

Detmold's suggestion, which, though presented especially for controlling hemorrhage from wounds involving the lungs, applies as well to all hemorrhages beyond immediate reach, was published nearly seventy years ago and reads as follows:

Now, as a general rule, wounded men do not bear well depletion; in most cases the soldier's constitution has already been weakened by fatigue, exposure, and camp diet, and the wounded men want all the stamina to withstand the effects of prolonged and perhaps profuse suppuration in the hospitals, where in many cases the means are deficient for building up an enfeebled constitution. I would, therefore, strongly recommend to you a remedy, which, while it gives you all the advantages to be derived from copious and repeated venesections, is free from all its injurious results; this remedy consists in applying ligatures to the limbs by a circular pressure to the upper parts of the arms and thighs, tight enough to check superficial venous circulation without affecting the deeper arterial influx of blood. By this means, which is easily put into execution, you may temporarily withdraw any amount of blood from circulation without depriving the

wounded of a single drop, the want of which might seriously affect his recovery; for when the momentary and imminent danger of life has ceased, that is, when the pulmonary hemorrhage has stopped, you gradually loosen the ligatures and allow the blood which you have retained for a while harmlessly in the extremities to re-enter circulation.

My attention was called to Detmold's method through Holmes' "System of Surgery." My first case was an ideal one; a woman, sixty years of age, had been for some hours vomiting large quantities of blood; she was breathing with difficulty; was cold and nearly pulseless. Considering her age, I assumed she was suffering from cancer of the stomach. I applied bandages to the extremities, close to the trunk as directed by Detmold, and was delighted to find the hemorrhage promptly controlled. After waiting a reasonable time I released the constrictions, thus restoring the blood to the circulation. She made a prompt recovery and belied my presumptive diagnosis by living nearly twenty years with no recurrence of hemorrhage.

Not long ago a case of fatal gastric hemorrhage was reported at the staff meeting of one of our local hospitals; the autopsy showed that the hemorrhage came from the duodenum. The case was reported by the Professor of Medicine in our local medical college, a graduate of the Johns Hopkins school. He had promptly used the ordinary means for checking hemorrhage but without avail. When I suggested to him in the discussion the Detmold method he heartily approved of it, but said he had never heard of it.

A similar fatality has been reported from the Massachusetts General Hospital.² In this case the conditions present were apparently identical with those in the personal case reported here; my patient,

¹ Vol. 1, p. 455, 1881.

² *New England J. Med.*, 206: 294, Feb. 11, 1932.

* Submitted for publication March 4, 1932.

however, being a woman sixty years old, while this patient was a man of sixty-three years. The usual means of treatment were followed in this case, including, but perhaps ill-advisedly, transfusion, but apparently no one had any knowledge of the Detmold treatment, and during the later discussion of the case not one of the seven staff physicians who took part mentioned this treatment or apparently had any knowledge of it. The patient entered the hospital "forty-eight hours" after the primary hemorrhage and the diagnosis was promptly made; but he was allowed to drift along and "on the eighth day he died!" The autopsy showed plainly that the Detmold treatment would almost certainly have permitted a later operative procedure.

Three physicians of Brooklyn, N. Y., report³ two fatal cases of ulcer of the stomach with autopsy, with certain advice as to operative intervention in such cases, but with no suggestion as to control of hemorrhage until the patient could be gotten into condition for comparatively safe operative procedures. Their only recommendation seemed to be the standard one of morphine, with perhaps transfusions.

Max Einhorn, of New York, in discussing the "Management of Acute Hemorrhages in Peptic Ulcers,"⁴ advises in the treatment "perfect rest abed, ice bag over the stomach, injecting thromboplastin or blood serum, and alleviating pain by sedatives." He reports in detail two cases, but not a word about the possible need of the Detmold treatment.

During the last two years I have taken many opportunities to question hospital interns and other recent graduates as to the Detmold method, but no one of them had ever heard of it. I have also looked through a considerable number of works on surgery, but have found no mention of it.

R. H. M. Dawbarn (1860-1915)⁵ describes what he calls "sequestration anemia,"

³ *Am. J. Surg.*, 15: 304, 1932.

⁴ *Med. J. & Rec.*, 135: 219, March 2, 1932.

⁵ *Keen's System of Surgery*, Phila., Saunders, 1921, Vol. 5, p. 192.

which he secures by bandaging the extremities as recommended by Detmold, but he recommends this merely as a preparation for an operation in which he anticipates much hemorrhage. Horsley⁶ also refers to "sequestration anemia," but like Dawbarn makes no mention whatever of that procedure to check bleeding. He cautions against the use of it, however, because in some cases he thinks it increases shock. Welch, however, states⁷ very positively that "a stationary column of blood included in an artery or vein between two carefully applied aseptic ligatures within the living body may remain fluid for weeks."

This treatment should unquestionably be instituted in all cases of hemorrhage in which direct treatment to reach the bleeding point is impossible, and would include, therefore, large hemorrhages from the lungs, stomach and bowels, and possibly, under some rare circumstances, could even be used, at least for temporary purposes, in uterine hemorrhages.

Both Dawbarn and Horsley warn against leaving the constricting bandages on too long, but advise releasing them from time to time at perhaps fifteen to thirty minute intervals; probably releasing, however, one at a time so as to maintain the efficiency of the "sequestration."

How many times I have used the Detmold method for thus stopping bleeding I do not know, but so far as I can recall I have never had any unfortunate results but have quite uniformly accomplished the desired end.

The bandages recommended by Detmold could probably be more satisfactorily substituted by rubber tubing or ordinary tourniquets, but bandages are always obtainable.

They have a saying in Texas, we are told, to the effect that "a man seldom needs a pistol, but when he does he needs it mighty bad." The same is true with sequestration in certain cases of inoperable hemorrhage, and every surgeon should certainly keep in mind this method.

⁶ *Operative Surgery*, Ed. 3, St. Louis, Mosby, 1928.

⁷ *Johns Hopkins Press*, 1: 47, 1900.

LYMPHANGIOMA OF THE RECTUM*

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AS no mention is made of this type of tumor in this particular location in any of the textbooks on diseases of the rectum, a report of the following case with the pathologic findings will be of interest to both the proctologist and pathologist.

A cursory review of the literature shows but a solitary brief allusion to such a condition by Kaufmann¹ in his textbook on Special Pathology, who cites a case of lymphangioma recti in his own experience. It was a cystic lymphangioma the size of a walnut in a male patient, situated in the submucosa of the anterior wall.

CASE REPORT

Mrs. P. F., housewife, aged thirty-eight, came to the office July 8, 1927. She gave a past history of the usual diseases of childhood, of an attack of typhoid fever in 1914, of influenza in 1918. An operation for appendicitis and bilateral salpingitis had been performed on her in 1923.

She began to have pain and discomfort in the rectum about two years prior to her first visit with a sensation of burning and fullness following stool. She reported that considerable blood was discharged with a very uncomfortable feeling. These symptoms were constant up to the time of the first call.

Rectal examination showed a few skin tags around the anus, also several small internal hemorrhoids. A mass, the size of a walnut, was felt in the right posterior quadrant extending up to the rectal pouch. The tactile impression was like that of a thrombosed vessel. The mass bled on palpation.

Proctosigmoidoscopic examination revealed a small tumor with the mucosa ulcerated, localized in the right posterior quadrant of the

rectum; otherwise, the rectum and sigmoidal mucosa were normal. A tentative diagnosis of carcinoma of the rectum was made and oper-



FIG. 1. Lymphangioma of rectum. $\times 7$.

ation advised. Three weeks later, under sacral anesthesia, the mass was completely excised. The patient made an uneventful recovery. Three months after the operation a proctologic examination revealed a normal condition of the rectum. Since that time, now almost four years, there has been no complaint of any rectal disturbance.

Pathologist's Report (Dr. Philip Hillkowitz): The tissue removed at operation measures $1 \times 0.5 \times 0.5$ cm. and is of moderately firm consistency. It is lined on one side by mucous membrane.

Sections reveal a normal mucosa with glands lined by a single layer of columnar cells showing no atypical proliferation. In the submucosa and extending across the entire section is a fibrous stroma presenting a honeycomb appearance. There are numerous round spaces lined by a single layer of endothelial cells.

¹ Kaufmann, E. Lehrbuch der Speziellen Pathologischen Anatomie. 9th and 10th Ed., Vol. 1, p. 750, Berlin, 1931.

Many arterioles and dilated veins are seen in the supporting stroma. The spaces vary somewhat in diameter but the majority

produced an interference with the outflow of lymph and given rise to dilatation of the existing lymphatics?



FIG. 2. Lymphangioma of rectum. $\times 33$.



FIG. 3. Lymphangioma of rectum. $\times 100$.

measure 130 microns. Occasionally there is a tear in a narrow wall separating two adjacent spaces and a larger interstice results. In following down the mucosa in the anal direction, the surface lining abruptly becomes the stratified squamous epithelium. Here too under the epithelial layer we find the honeycomb arrangement as described above.

DISCUSSION

The question as to whether we are dealing with a true neoplasm or a lymphangiectasis is usually propounded in the investigation of lymphangiomata. Could the previous operative procedures have

In our opinion such a possibility is remote and we incline to the more rational view of the neoplastic nature of the nodule.

SUMMARY

History and pathologic findings are given in a case of lymphangioma of the rectum in a woman of thirty-eight, simulating carcinoma by proctosigmoidoscopic examination, but whose true nature was revealed under the microscope. Symptoms disappeared following excision with maintenance of good health four years after operation.



ATTEMPTED SUICIDE BY USE OF GUN AND CARTRIDGE OF DIFFERENT CALIBER

REPORT OF A CASE*

J. ROBERT JOHNSON, M.D.

CHICAGO

MR. W. E. D., aged twenty-five, single, a periodic drinker with unmistakable evidence of emotional instability, on December 25, 1930, attempted suicide in the following manner: Having only a .32 caliber revolver cartridge and a .410 gauge (12 mm.) shotgun, he fitted the two together by first wrapping the cartridge in the tin-foil wrapper from a stick of chewing gum, then winding electrician's tape around this until it was large enough to fit tightly into the chamber of the gun. Next, he forced the shell with its wrappings into the chamber of the gun, made it ready to fire, and placed the butt on the floor and the muzzle against the left breast near the heart region. In stooping over to reach for and press the trigger with his right hand, he turned his body, lowering the right shoulder in order to increase his reach. Thus, at the moment the trigger was pressed, the barrel of the gun was almost parallel to the chest wall and directed to the left.

Examination. There was a short vertical slit, obviously torn, in the shirt; and a small round perforation in the underwear over the left breast. Starting over the third rib, 3 in. (7.6 cm.) to the left of the sternal margin was a short, wide abrasion, the left border of which was contiguous with a round perforation the size of a .32 caliber bullet. From the perforation, a subcutaneous tunneled wound ran 1½ in. (3.8 cm.) to the left between the third rib and skin; at the end lay the bullet, which was easily expressed. Powder marking was absent on skin and clothing. There was no evidence of rib or internal thoracic injury.

The bullet was of soft lead, .32 caliber, and was slightly flattened on one side. The exploded shell was found in the chamber of

the gun, wrapped as described, and was removed. The gun barrel was seen to be heavily coated with powder granules and smelled of freshly burned gunpowder.

Treatment was ordinary and healing uneventful.

COMMENT

The interesting and unusual features of this case are: (1) The use of a cartridge of a small caliber in a larger caliber firearm is unusual and might lead to misinterpretation, especially by the police. If the gun were missing (as it was, for a time, in this case), the caliber of the bullet recovered and the lack of powder stains on the clothing or body would lead one to search for a .32 caliber revolver, fired at some distance by another person with, perhaps, criminal intent.

(2) The lack of powder burning is surprising, considering the very close range, and may be attributed to the almost total absorption of the small powder charge by the long barrel of the gun.

(3) The penetration of the missile was very slight because of the low muzzle velocity. There was great loss of velocity in the barrel of the gun because the force of the explosion escaped around as well as behind the bullet.

(4) Ballistic tests on the gun and bullet would be unsatisfactory. It would be difficult or impossible to duplicate the scratch marks on another bullet fired from the same gun.

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The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the Country, but it is not "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

EDITORIALS

BIOPSY

BIOPSY as a diagnostic procedure is bound to become quite as essential where it is indicated in the routine examination of the human body as are blood cell counts and urinalysis. The latter, of course, are indicated in every case while biopsy is indicated only in the presence of a localized or generalized pathology.

In the past biopsy as a routine procedure in those cases in which it is indicated has been practiced more or less sporadically. However, during the past decade and perhaps more markedly during the past five years, biopsies have gained a foothold which has fully demonstrated their real worth.

Through the medium of biopsy a safe and certainly a more accurate diagnosis of the individual tissue pathology can be determined preoperatively. To be able to reach a definite decision, preoperatively, regarding the true pathology of any growth or tumefaction is a step in the right direction.

Again, it opens the way for a free discussion and wider field of consultation preoperatively when there arises a question as to the definite pathology of any area of the human body. The wider the field of investigation, the more liberal the views from multiple consultations. Greater cooperation in any case means not only a safer

judgment as to the method of procedure but also a more definitely successful outcome for the patient.

The fact that the patient is the most important individual in the hospital must never be overlooked. Anything within our power that will enhance the status of prognosis is certainly warranted and merits the support of all. This is just what biopsy does in any individual case.

All tumors and malignant growths deserve the serious consideration provided by biopsy. Through this medium the proper method of treatment can be determined. The study of the character of the individual cell means a great deal in moulding proper judgment upon which to give advice regarding the best method of procedure. Biopsy is always a great aid in finally determining whether the special growth in question warrants radical surgical intervention, instillation of radon seeds, application of mass doses of radium or superficial or deep x-ray therapy. It will also determine whether or not a combination of these methods of treatment will prove more advantageous. Biopsy will also determine whether or not it is advisable to use radium or x-ray therapy preoperatively, postoperatively or possibly both. In other words the universal adoption of biopsy as a routine in all tumor and malignant cases

where possible seems the feasible thing to expect in the very near future.

The sooner the medical profession as a whole comes to realize fully the real worth of biopsy in cases of tumors and malignancy the sooner will there be established a standard upon which to proceed with greater accuracy. Through this medium a sounder basis for better judgment will be reached; a sounder basis for better judgment upon which to think and act in giving advice to patients in determining the outline of procedure preoperatively, operatively and postoperatively, in outlining to the patients the best care during the two or three year period following discharge from the hospital, in the prognosis regarding these highly important tumors and malignant cases.

It is not difficult to foresee the era in the teaching of medical science when biopsy will become a specialized part of the field of surgical pathology and will be so taken up in our medical schools. Biopsy offers a wide field in medical teaching as well as in medical practice in all its branches. It is bound to receive more emphasis in the future and the members of the medical profession should early grasp its true meaning and practical usefulness to the extent that all hospitals are required to make it part of their regular routine.

G. S. FOSTER, M.D.

ERRATUM

In the June issue of THE AMERICAN JOURNAL OF SURGERY, vol. xvi, No. 3, page 415, column 2, line 15, through page 416, end of column 1, is a discussion by Dr. Clyde Wilson Collings of New York, on the paper by Dr. Theodore Davis of Green-

ville, S. C., on "Transurethral Correction of Prostatic Obstruction." By mistake, this discussion was not credited to Dr. Collings and appears as part of Dr. Kirwin's discussion.

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AMERICAN PHYSICIANS

JOHN FLEET*

JOHN FLEET is recognized historically for having been the first to receive a medical degree from Harvard, and for having been one of the founders of the Medical Improvement Society (1803), which society grew into the first Boston Medical Library (July 1, 1805).

He was born in Boston, April 29, 1766. His grandfather, an Englishman, upon settling in Boston, became engaged in printing and book-selling, and published a paper, *The Evening Post*, which we are informed was the best in New England, and "Fleet's Almanacks," which was an authority for many years. It is debatable if he was the original compiler of the "Mother Goose Melodies."

The grandson, the subject of this Biographical Brevity, graduated from Harvard College in 1785 at the age of nineteen years. Following his graduation he studied medicine in the Medical Institution of Harvard College. He dissected under Dr. John Warren. Prior to 1788 no medical degree had been granted by the College. In that year, however, John Fleet and George Holmes Hall applied for degrees. These were granted on July 16, but only after a heated professorial discussion.

The degree was that of Bachelor of Medicine. As Fleet's name came first alphabetically, he was thus the first to receive a medical degree from Harvard.

Seven years later (1795) Fleet was the first to receive the degree of Doctor of Medicine from the College. To get the degree he passed an examination and presented a thesis in Latin, "*Observationes ad Chirurgiae Operationes Pertinentes.*" His brother, Thomas, printed it. A copy of this is in the Boston Medical Library.

Fleet was the first assistant appointed in the Medical Department of Harvard College (assistant to Dr. John Warren, 1793).

His friends were the best medical men of Boston. He was one of the prominent founders of the Medical Improvement Society from which grew the Boston Medical Library. Fleet was the first librarian. In the beginning the books were kept at his house in Milk Street. Fleet, also, was librarian of the Massachusetts Medical Society from 1800 to 1813.

John Fleet never married. He died in Boston in his forty-seventh year, on January 4, 1813.

T. S. W.

*At the time of going to press a portrait of John Fleet had not been found. Should one come to light it will be included in a later issue. The Publishers will appreciate hearing from anyone who knows of such a portrait.





[From Fernelius' *Universa Medicina*, Geneva, 1679.]

BOOKSHELF BROWSING

DR. WILLY MEYER

ON February 25, 1932, just past midnight, Dr. Willy Meyer reached the end of the path of life. He died in the New York Academy of Medicine, in the room where the New York Surgical Society had just adjourned its meeting. It had always been his wish to die in harness, and this wish was fulfilled. After discussing a paper on "Cancer of the Breast," a subject which was one of the outstanding achievements of his life, he sat down with a severe heart attack, from which his many colleagues, friends, and associates who surrounded him could not save him. Death overtook him on that spot where some forty-five minutes before he had been calling out hope and encouragement to those cancer sufferers to whom, towards the end of his life, he had devoted himself.

On the banks of the River Weser, in Westphalia, Germany, lies the beautiful city of Minden. Here on July 24, 1858, Willy Meyer was born, the son of Abraham and Bertha (Simon) Meyer. He was the third of three sons. This triumvirate remained intimately united until Willy Meyer's death, the two older brothers, Julius and Theodore, surviving, and also living in America.

Besides these brothers, there are two younger sisters and one younger brother surviving.

Willy Meyer enjoyed a typical German education, attending and graduating from the Gymnasium in Minden, which he visited from 1867 until 1876. Here he had a thorough foundation in the classics, especially Latin and Greek, and also English. This knowledge of Latin and Greek stood him in good stead, as Prof. Busch, Chief of the Surgical Clinic in Bonn, under whom he later worked, insisted on conversing only in Latin in the presence of patients. "*Ante patientem Latina lingua est.*"

In the spring of 1876 he entered the University of Bonn and studied there until the spring of 1878, when he transferred to the University of Erlangen for one year, only to return to Bonn in the spring of 1879, and to graduate as a Doctor of Medicine on August 7, 1880.

During the year he was in Erlangen he served the first six months of a year's voluntary military service in the Sixth Bavarian Jaeger Battalion of the German Army. The second six months, from April, 1881 until October, 1881, he spent as Volunteer Surgeon of the Fifteenth Infantry Regiment in Minden. He was honorably discharged from the German Army on February 21, 1884, as a Reserve Surgeon of the Seventh Hussars Regiment.

During his college days in Bonn, Willy Meyer joined the fraternity known as

"Allemania," and spent many happy days and hours in the fraternity group on the banks of the majestic Rhein and the beautiful nooks and corners of its many tributaries, where the fraternity members frequently made excursions. This instilled in him his great love of nature and the beauty of outdoor life.

During his student fraternity days, he fought two sabre duels and bore the scars of these on his chin and head. Of these, in typical German student fashion, he was very proud.

He greatly enjoyed reminiscing and frequently spoke of the happy student days, and the wonderful and profound influence which these days had upon his life.

His mother was anxious for her son to become a pianist, in which art he was very proficient, but during one summer vacation Dr. Abraham Jacobi visited Germany from America, and being an uncle by marriage, called upon the family in Minden. He asked the young student, Willy Meyer, to accompany him on a tour of some of the medical clinics as his personal secretary. This Willy Meyer did, and this experience instilled in him the desire to become a physician. He asked his parents' permission, which was granted. Thus his medical career began.

Graduating as a doctor in 1880 from Bonn, he joined the medical faculty of the University of Bonn in October, 1881, as assistant in the medical clinic. In this position he remained for two years, and then became first assistant in the clinic in October, 1883, remaining until the fall of 1884, when he emigrated to America. During this year he was assistant to Prof. Wilhelm Busch, Surgeon General of the German Army in 1870. Busch died suddenly. Prof. Madelung then became chief of the clinic, but some months later was transferred to Strassburg. Hereupon Friedrich Trendelenburg became Professor of Surgery, and Willy Meyer was his first assistant, assisting him at all of his operations. A close and lifelong friendship ensued. Trendelenburg was so impressed

by the ability of his young assistant that he honored him by asking him to publish the first account of what was later to be known throughout the medical world as the "Trendelenburg Posture."

Great advances were made in surgery during these years, and they left a lasting impression upon Willy Meyer and his entire future career. Germany rapidly introduced Sir Joseph Lister's principles of antiseptic surgery. The carbolic acid spray was used in the clinic at Bonn, and Willy Meyer often told the story of how Prof. Busch entered the amphitheatre one day, and, with a trembling voice, told his students that a young boy, the only child of a widow, had died of carbolic acid poisoning after an operation on the knee-joint performed under a carbolic acid spray.

Then with the development of bacteriology and Robert Koch's discovery of the tubercle bacilli, there developed the principles of sterilization of all instruments and operative materials. All surgical clinics rejoiced when the call appeared in literature, "Weg mit dem Spray" (Away with the spray).

Willy Meyer lived during and through this epoch-making period of surgery. It was fascinating to hear him tell of these interesting years.

An important fact and observation occurred in the service under Busch which had a great effect upon his later life, work, and thought. Prof. Busch had a patient with a bad ulcerating carcinoma of the breast. This patient developed erysipelas, had high fever, and was desperately ill for many weeks. She finally recovered, and when she was well of the erysipelas, the ulcerating cancer was also well. This thought and fact remained imprinted upon Willy Meyer's mind, and in the later years, from 1920 to 1930, when the dust of the busy road of life was fast falling on his head and he was turning gray and white, this fact appeared to help formulate the philosophy and thought behind the thesis as developed in his book "Cancer"—the acidosis produced by fever.



WILLY MEYER
[1858-1932]

During his childhood days, he met Lilly Maass of New York, who visited Minden each summer. Their parents were life-long friends. This childhood friendship developed into love, and as a young doctor he became engaged to Lilly Maass in 1881. They were engaged four years, during which time his fiancée was in New York, only visiting Germany in the summer, and Willy Meyer was assistant in Bonn. It was on her account, and upon the advice of Abraham Jacobi, that Willy Meyer emigrated to America in the fall of 1884.

He settled in New York, and with his splendid German medical and surgical training and his burning enthusiasm for hard work, he gained a foothold in America. He was helped by many older friends, who recognized his unusual ability and fine character. He started in the general practice of medicine. In April, 1885, seven months after reaching the hospitable shores of our country, he was in a position to get married. A year later he specialized only in surgery.

Immediately after his arrival here, he was admitted to the German Dispensary as Assistant in the Surgical Department. From 1886 to 1893, he was Professor of Surgery at the Woman's Medical College, and all his life he had the keenest interest in the welfare of the College and in the New York Infirmary for Women and Children, where he was consulting surgeon. He gave a helping hand at all times to women doctors, for whom he held the highest esteem and greatest regard, and aided the cause of women in medicine to the last.

In 1886 he was appointed Attending Surgeon in the New York Skin and Cancer Hospital, now the Stuyvesant Square Hospital, where he remained active until 1902. Early in his career he performed extensive operations. Possessing a profound knowledge and understanding of the pathology of cancer, he performed the most radical operations for all malignant conditions.

In 1894 he published the principles underlying the technique he advised for the radical operation for cancer of the

breast as he understood it. This type of operation, involving the removal of the breast, both pectoral muscles in their entirety, and complete axillary lymph-node dissection, bears his name. Even at present this operation in principle can not be improved upon. It was this subject that brought him just fame early in his career in America as a surgeon, and it was on this same subject that he delivered his last message to the medical and surgical world. His teachings on this subject and his influence are everlasting, and will continue on, and bring hope and health to countless patients in the future.

In 1886 he was appointed Attending Surgeon at the German Hospital, now the Lenox Hill Hospital. Here he developed his fame as a general surgeon. All his life he felt that it was important that a surgeon should be proficient in all departments of surgery. Being likewise appointed Attending Surgeon to the New York Post-Graduate Medical School and Hospital in 1887, and later Professor of Surgery, he introduced the German methods of teaching in his clinics. There was nothing in life that gave him more pleasure than to teach, to help others, to encourage young men, and to give a helping hand to everyone and anyone.

Whatever new developed in this country, or whatever new came from abroad, he immediately adopted it, and if from abroad he introduced it to America. He was a true pioneer in surgery. He was one of the first to introduce cystoscopy to America. With the electric cystoscope in 1896, he was the first surgeon in America to successfully perform the catheterization of the male ureters. He wrote many papers on the subject of genitourinary-surgery.

In 1897 he was the first in America to perform Bottini's operation for hypertrophied prostate, on the basis of which the present modern improved method of electrocautery knife operation is performed for similar conditions.

He was also one of the first surgeons to introduce in America the modern methods

of gastrostomy and gastroenterostomy (1894 to 1896). In 1908 he published a book on Bier's hyperemic treatment in which he was a great believer.

In 1895 his eldest daughter, nine years old, developed an acute appendicitis. This was just at the time after McBurney in 1890 had begun to successfully operate upon appendicitis. She was operated upon on the third day of the third attack, and died on the third day after the operation, from peritonitis. Stunned and crushed by this irreparable loss, he began an intensive study of the subject, and wrote many papers. He stamped appendicitis a surgical disease, and urgently advised immediate operation during or immediately after the first attack.

Early in the twentieth century, from 1904 on, Willy Meyer devoted much time and interest to thoracic surgery. This part of the human body was still somewhat inaccessible to the general surgeon. The thought of entering an unknown field fascinated the energetic and fearless surgeon. When Prof. Sauerbruch came to America in 1907, he brought with him one of his negative chambers. He invited Willy Meyer to assist him in a thoracic operation upon a dog before a group of prominent surgeons. To Willy Meyer's joy and amazement, Prof. Sauerbruch said that he would leave this negative chamber in America for his use.

This spurred him on to intensive study, and despite his work in hospitals and private practice, he spent two afternoons a week at the Rockefeller Institute for Medical Research, experimenting on dogs. Quickly he recognized the inadequacy of the Sauerbruch chamber, and instigated his eldest brother, Julius Meyer, an engineer, to study the problem. The aim of these brothers was to develop a chamber in which, without moving the patient, chest operations could be performed either under negative or positive pressure, in order to find out which was best for the sick human being. This they accomplished, and built a negative chamber which was

first used experimentally at the Rockefeller Institute and then transferred to the Thoracic Pavilion of the Lenox Hill Hospital, one of the only pavilions of its kind in the world. Here many operations were performed on humans. Despite many early failures and heartrending disappointments, Willy Meyer's indomitable enthusiasm and devotion to duty, and an unsurpassable courage, and infinite patience and perseverance soon led to happier results. He wrote continuously on thoracic surgery subjects, and helped to lay the foundation for thoracic surgery in America.

Quickly other surgeons took up the banner and aided in establishing this special field of surgery.

The Great World War rapidly advanced thoracic surgery, and showed that negative pressure was not essential in all cases.

In 1917 Willy Meyer called together all those surgeons especially interested in thoracic surgery, and he founded the American Association for Thoracic Surgery, which has grown and prospered, and is now flourishing in its fifteenth year.

He also founded the New York Society for Thoracic Surgery, which holds two meetings a year, at which thoracic subjects are discussed. This past year the *American Journal for Thoracic Surgery* has been successfully launched, which shows the marvelous development of this fascinating field of surgery, to which Willy Meyer gave so much of his life, energy, and thought.

When the United States entered the World War, Willy Meyer became Major in the Medical Reserve Corps. He was not called to active service, on account of his age, but one of his outstanding characteristics was his sincere, loyal, and splendid citizenship, his endless interest in city, state, national, and international politics. He spoke of Germany as his mother, and remained grateful to her for all that she gave him in his youth, and education. But the United States he spoke of as his bride, and he always maintained that even though born a

German, his first fealty, devotion, support and loyalty belonged to the bride, even though he still maintained his love for the mother, Germany. He was one hundred per cent an American. He maintained that science, as also music, should recognize no national boundaries; and following the War, he tried to help his stricken colleagues and friends abroad. He was interested always in every type of charity in which he felt that aid would be of value. He was a thirty-second degree Mason.

The welfare and good of the community, especially as to health, was deep-rooted in Willy Meyer. For over forty years he spent the summer at Lake George, at his simple but lovely home. For years he was chairman of the Sanitation Committee of the Lake George Association. He devoted much time, thought and energy towards the health and welfare of the country people. He prided himself in the knowledge that through the efforts of the Lake George Association and his committee, Lake George was the cleanest, purest, and most healthy body of inland water of its size and shore population.

In 1918 Willy Meyer, together with his older brother Julius Meyer as a literary assistant, began an intensive study of cancer literature. He followed all leads of all theories published, and after ten years of the profoundest kind of study and work, he came to the conclusion that cancer was a systemic disease. As age advanced, his active surgical work naturally diminished. But his burning desire to continue until the last, his lifelong devotion of service to mankind, and his active, marvelous young mind, not influenced in the least by advancing years, permitted him, in the solitude of his study, to think, to ponder, to philosophize. He canvassed, in his life's work, his active surgical and clinical experiences, and studied the literature of others, and with the memory of that memorable case of his youth in Bonn, when, under Busch, erysipelas cured the cancer, he formulated the theory as stated in his book published in 1931, "Cancer: Its Origin

and Development: The Theory of Inoperable Cancer in the Light of a Systemic Conception of Malignancy."

He refused his help and services to no one who asked for them. A few weeks before his death he accepted an almost hopeless case of cancer of the rectum. One of our large hospitals for malignant disease had discharged the patient as hopeless—sent home to die, relieved of suffering only by morphine. Willy Meyer accepted the patient and operated upon her twice, the last time less than a week before his death. At seventy-three and a half years of age, his lifelong courage had not left him. He resected the sacrum, curetted away all the inoperable, fungating tumor, and then took a cherry-red cautery iron and ruthlessly burned and cauterized the entire base of the tumor. He then ordered treatment by the acidotic treatment and irradiation later on. A week later he died. As if it had been a memorial to his memory, the patient has clinically improved, and two months after the last operation, was able to leave the hospital in general excellent condition.

Willy Meyer's enthusiasm and courage must live on. Others must take up the reins. His theory must be proved right or wrong. In his broad-minded way, Willy Meyer thought that perhaps he was on the right track—no final solution or cure, but somewhere on the right track. It was his burning desire to live on, and he had made great research plans for the years to come, and had decided to devote his life to the cause of cancer itself.

God has willed it otherwise, but the name of Willy Meyer is indelibly imprinted on the pages of the legion of crusaders who work against the scourge of cancer.

As a husband and father, Willy Meyer's life was one of self-sacrifice, adoration, love, and devotion. His family life was a thing of beauty, a monument to a great man. He was married for forty-one years when his wife died three years ago. All their lives he showered her with devotion, attention, and self-sacrifice, which were

eloquently reflected in his wife's devotion and self-sacrifice for him.

He is survived by a daughter, Marjorie Meyer Flemming, and her husband; she gladdened his years by her proficiency in music, especially in singing. His only son, Herbert Willy Meyer, followed in his profession. They were intimately associated in practice, as brothers more than father and son, confided in one another, assisting one another in everything. His son was his House Surgeon in 1920 at the Lenox Hill Hospital and later his adjunct, until the father reached the age limit in 1923, and became consulting surgeon. It was a beautiful relationship.

His daughter-in-law and his two little grandchildren, five and three years old, were his joy and happiness. His life in the last years centered around them, and they helped to keep him young.

As a man, colleague, physician and friend, Willy Meyer's outstanding attributes were his kindliness, his gentleness, his sweetness of character. He was beloved by all who came under the spell of his influence and charm. Age, race, creed, or color made no difference to him. He reached out a helping hand to everyone, and rejoiced if there was anything he could do to help someone else, especially another colleague.

Willy Meyer was a real man, kindly, wise, generous to friend and foe, a constant stimulus to work and the joy of living. He leaves a heritage of honor, ability, energy, faith and charity. It seems weirdly and correctly fated that his life should have ended in the Academy of Medicine, and that he should have been permitted to leave the world in the medical atmosphere he so loved.

H. W. M.



COLLECTED PAPERS OF THE MAYO CLINIC AND THE MAYO FOUNDATION. Edited by Mrs. Maud H. Mellish-Wilson and Richard M. Hewitt, M.A., M.D. Volume XXIII. Phila., W. B. Saunders Co., 1932.

All that need to be said about Volume XXIII of the famous "Mayo Papers" with its over 1200 pages of text matter and 265 illustrations is that it lives up to the standard of excellence set by the previous volumes. More than this need not be said of any work. It may not be amiss to point out as the editors do in the Preface, that 577 papers emanated from this Clinic in 1931. "Of these ninety-nine are reprinted in full, thirty-six are abridged, forty-three are abstracted, and of 399 only the titles are given." The careful editing of these annual volumes makes this set a perfectly splendid reference library for every practicing surgeon.

HUMAN CANCER, Etiological Factors; Precancerous Lesions; Growth; Spread; Symptoms; Diagnosis; Prognosis; Principles of Treatment. By Arthur Purdy Stout, M.D. Phila., Lea & Febiger, 1932.

In this work cancer is considered from the standpoint of the surgery and surgical pathology in particular. The subject is covered in a thoroughly comprehensive manner and it is about as satisfactory a single volume on this subject as can be found today. The subject of cancer, its diagnosis and treatment is today of such prime importance that any volume that treats the subject in conservative fashion is to be welcomed. Dr. Stout has succeeded in furnishing just that material which the surgeon needs for study and reference. Written in an unusually clear manner, the book is a splendid addition to our cancer literature. We leave it to the cancer specialist to differ with the author on various specific points. Taken all in all, it is one of the most satisfactory books on the subject that we have seen.

FRACTURES. By Meurice Sinclair, C.M.G., M.B., B.CH. (Edin.) with an Introduction by Sir Robert Jones, Bt., K.B.E., C.B., F.R.C.S., Modern Surgical Monographs, Edited by G. Gordon Taylor, O.B.E., M.A., F.R.C.S. London, Constable and Co., Ltd., 1932.

Any book on fractures with a preface by Sir Robert Jones is sure to command attention.

The book before us has 550 pages and 337 illustrations, mostly x-rays. The present status of the treatment of fractures in England is well presented in this volume. We miss reference to the method of treatment of Dr. Böhler of Vienna and to many American methods which evidently have not yet been adopted in England. For supplementary reading, this book may be heartily recommended to the American surgeon.

MANIPULATIVE SURGERY. By A. S. Blundell Bankart, M.A., M.CH. (Cantab.), F.R.C.S. Modern Surgical Monographs, Edited by G. Gordon Taylor, O.B.E., M.A., F.R.C.S. London, Constable and Co., Ltd., 1932.

According to the author: "It is only in recent years that the ancient practice of manipulation, or moving joints for therapeutic purposes, has been dignified by the title of 'manipulative surgery.'"

The author has succeeded in covering the subject completely and has made a step towards obtaining for the subject the more dignified position which he claims for it. In a little over 150 pages, Dr. Bankart treats his subject with a remarkable degree of thoroughness. Regarding Osteopathy he says: "Osteopathy is a typical American money-making stunt. It is based upon an imaginary displacement or subluxation of one of the lateral joints between two adjacent vertebrae." This is a statement with which most American surgeons will find no difficulty in concurring. A book of this kind has been needed and a great part of its value consists in its showing that surgeons are not against the use of manipulation where necessary while avoiding at the same time making thereof the cure-all which is claimed for it by exploiters.

SURGERY WITH SPECIAL REFERENCE TO PODIATRY. By Edward Adams, M.D. Burlington, Vt., International Journal of Surgery Co., 1932.

There is undoubtedly a field for a book of this kind but it is to be doubted whether this volume will fill the bill. The volume is an enlarged revision of a book written by the author in 1917. The peculiar construction of the book is perhaps best expressed by the author's statement that the book has been written and compiled primarily for the student

of podiatry. He also hopes that the industrial surgeon will find much of interest and value therein. Like so many volumes that try to satisfy several classes of readers, the work falls between two stools. While it is probable that it contains much that the chiropodist needs to know, it is doubtful whether it offers much to the practicing surgeon. There is a glossary of twenty pages in which it is frankly stated that the definitions have been taken from *Stedman's Dictionary*. It would seem better to advise having *Stedman's Dictionary* at hand rather than to take selections therefrom. The typography is different from any other book with which the reviewer is acquainted and not particularly attractive.

MODERN TREATMENT ANAESTHESIA. By W. Stanley Sykes, M.A., M.B. (Cantab.), D.P.H. (Leeds), M.R.C.S. With a Section on Local Anaesthesia by P. J. Moir, M.C., M.B. (Glasgow), F.R.C.S. (Eng.). N. Y., W. W. Norton & Co., Inc., 1932.

According to the author, this book is written for the "occasional anaesthetist" and as such evidently is considered to have a place in England. It is not felt that a work of this kind would be of much value in this country but where a need is felt for a rapid outline, this work may fill the bill.

APPROVED LABORATORY TECHNIC, CLINICAL, PATHOLOGICAL, BACTERIOLOGICAL, SEROLOGICAL, BIOCHEMICAL, HISTOLOGICAL. Prepared under the Auspices of The American Society of Clinical Pathologists. By John A. Kolmer, M.D., DR. P. H., D.SC., LL.D. and Fred. Boerner, V.M.D. Assisted by C. Zent Garber, M.D. and Committees of The American Society of Clinical Pathologists Composed of Dr. J. H. Black, Dr. H. J. Corper, Dr. A. C. Foord, Dr. A. S. Giordano, Dr. F. W. Hartman, Dr. P. Hillkowitz, Dr. R. A. Keilty, Dr. R. A. Kilduffe, Dr. K. M. Lynch, Dr. A. H. Sanford and Dr. F. E. Sondern. N. Y., D. Appleton and Co., 1931.

This work, published under the auspices of The American Society of Clinical Pathologists, may be considered the standard work on laboratory technique in this country. The methods contained therein have been approved

by this society which makes it as nearly official as is possible. The subject is thoroughly covered and the book is well arranged for quick reference. No laboratory, large or small, should be without it.

DIET PRESCRIPTIONS, Compiled from Accepted Authorities. By Oscar Baer, M.D. Niagara Falls, N. Y., Arnson's Service and Supplies, 1932.

Dr. Baer has published in this work over seventy-five diet prescriptions which have been tried and found useful. The diets are more or less standardized and are available also in loose sheets for distribution to patients. For physicians with a large practice, they will be found valuable and handy. The pages are large enough to permit of notations making changes for individual cases. The average case is well covered by these diets. This is a thoroughly practical book for which we bespeak a large sale.

SURGICAL CLINICS OF NORTH AMERICA (Lahey Clinic Number, Boston, Mass.) Volume XII, No. 3, Phila., 1932.

This number contains some 25 contributions from the Lahey Clinic in Boston. All of the important members of this Clinic have written special articles for this number and the volume lives up to the standard both of the publication and of the Clinic, which is high praise for any book.

EINFÜHRUNG IN DIE RÖNTGENTHERAPIE CHIRURGISCHER ERKRANKUNGEN (Introduction to Roentgentherapy of Surgical Diseases). By Privatdozent Dr. Josef Palugyay. Vol. XVIII of Radiologische Praktika. Leipzig, Georg Thieme, 1931.

This monograph of one hundred pages is full of concentrated information as to the indications, mode of action, and results of roentgen therapy in surgical diseases. Surgical tuberculosis and malignant affections have constituted the chief fields of effort in x-ray therapy since the earliest days. In later years, especially through the efforts of the Author, large use has been made of roentgen therapy in specific and nonspecific inflammations. Little attention is paid to technique but careful directions are given as to the dosage, not only in percentage of "skin erythema dose" (HED)

but also in "roentgens." The quality of radiation desirable is also described under each recommendation. Thus, the work presents a great contrast with most previous publications on roentgen therapeutics. Indeed, it is only within the last two or three years that it has been possible to produce a text containing such definite instructions, which are perfectly intelligible to a radiologist who has given himself the necessary education in his specialty to permit him to employ the x-rays in therapeutics with modern precision.

Among the subjects for which roentgen-therapy is recommended are furunculosis, panaritias, less severe forms of phlegmon, lymphangitis, and even in pneumonia, peritonitis and sepsis. Heidenhain and Fried's series of 1500 cases of pyogenic infection treated by the x-rays, is one of the numerous series cited. Erysipelas should not be overlooked as a favorable case for roentgen therapy. Parotitis, orchitis, postoperative pneumonia, thrombophlebitis, and osteomyelitis are all given as fields for the use of this agent. Tuberculosis in its surgical forms is a fruitful field for good results in x-ray therapy. All of the foregoing utilizes about one-third of the book. The remaining two-thirds is devoted to the cancer question, full of such information and advice as is most desired by everyone having to deal with this important field of therapeutics.

The work is the product of the Second Division of the Surgical Clinic of the University of Vienna, directed by Prof. Hochenegg.

ALLGEMEINE UND SPEZIELLE ELEKTROCHIRURGIE. By Dr. Med. Hans V. Seemen, mit einem Beitrag Elektrochirurgie der Geschwulste in Verbindung mit Strahlenbehandlung by Dr. Med. Otto Schurch. Berlin, Julius Springer, 1932.

The author of this book is the chief physician at the Lexer Clinic in Munich. Prof. Lexer in his Foreword says that he feels that this book gives a complete résumé of electrosurgery and above all that it gives a clear picture of its present stand, particularly at the Lexer Clinic. No exception can be taken to this statement and this work is undoubtedly one of the most practical that has been published to date. The illustrations, of which there are over 300, are unusually well selected and many of them represent the best in modern color printing. Without claiming too much for the electro-

surgical knife, the author has succeeded in presenting a remarkably fair picture of its present position in surgery and the supplement by Dr. Schurch on "Electrosurgery of Tumors in Connection with X-ray and Radium Therapy" is a splendid monograph in itself. The bibliography of over 30 pages presents an interesting picture of this most modern surgical procedure and it is interesting to note that English and American literature is thoroughly considered. All in all, the book is the most up-to-date and practical treatise on the subject known to us.

ELEKTRISCHE VERLETZUNGEN, KLINIK UND HISTOPATHOLOGIE. By Dr. Stefan Jellinek. Leipzig, Johann Ambrosius Barth, 1932.

This work on electrical injuries is based upon thirty years' experience in electropathology. It is probable that Dr. Jellinek has a larger experience in this line than any other man. It is divided into the following chapters: 1. Electro-trauma; 2. Subjective Perceptions of the Electrocuted and Objective Immediate Symptoms; 3. External Changes; 4. Severe External Injuries; 5. Injuries of the Internal Organs; 6. Affections of the Nervous System; 7. Pathologic Anatomy; 8. Histopathology; 9. Therapy: a. Problem of Resuscitation, b. Conservative Measures, c. Benzine Therapy, d. Active Injuries (indications and counterindications). It will be seen from this that the subject is thoroughly and completely covered and it may be said that the text bears out the promise of the Table of Contents. The illustrations, many of which are colored, are well selected and beautifully reproduced. All in all, this work is probably the most thorough and complete reference book on the subject extant. It is likely to remain the standard for many years to come.

LEITFADEN DER KOSMETIK, FÜR DIE ARZTLICHE PRAXIS. By Prof. Dr. A. Buschke, Dr. Alfred Joseph and Dr. Werner Birkenfeld. Berlin, Walter De Gruyter & Co., 1932.

As its title indicates, this is a primer of both medical and surgical cosmetics and as such fulfills its purpose. It replaces no other work but will serve well as an introduction to the subject for the physician who is not specializing therein. An English translation of this work should be well worth while.

CHIRURGISCHE INDIKATIONEN, für Ärzte und Studierende. Erster(allgemeiner) Theil. By Prof. Dr. Kark Reschke. Berlin, F. C. W. Vogel, 1932.

In 357 pages, 30 of which are devoted to bibliography and index, the subject of surgical indications is treated entirely from the German standpoint and, as such, this book has a very definite function. Not all of the indications for operations would be blindly accepted in this country but the reverse would also be the case were the book written in this country. It is well however to have available this book giving the German standpoint of today. All the references in the bibliography are to German literature. *This volume is to be followed by another, treating of the "special" organs and conditions.*

BOOKS RECEIVED

All books received by THE AMERICAN JOURNAL OF SURGERY are listed in this column as soon as possible after their receipt and this must be considered as adequate acknowledgement. Books that the Editor

considers of special interest to our readers will be reviewed in a later issue.

ANUARIO DENTAL, 1929-1930. Madrid, 1931.

ARTHRITIS DEFORMANS UND CHRONISCHE GELENK-KRANKHEITEN. By Hans Burckhardt. Stuttgart, Ferdinand Enke, 1932.

DICKDARMSCHLEIMHAUT (DIE), IHRE NORMALE UND PATHOLOGISCHE FUNKTION IM ROENTGENBILDE. By Werner Knothe. Leipzig, Georg Thieme, 1932.

ENGLISH-SPEAKING STUDENTS OF MEDICINE AT THE UNIVERSITY OF LEYDEN. By R. W. Innes Smith. London, Oliver and Boyd, 1932.

GESUNDE (DIE) UND KRANKE WIRBELSÄULE IM RÖNTGENBILD. By Georg Schmorl. Leipzig, Georg Thieme, 1932.

GROSSE ARZTE. By Henry E. Sigerist. Munchen, J. F. Lehmanns, 1932.

JAHRHUNDERT (DAS) DER STRAHLEN. By Josef Rosenthal. Leipzig, Georg Thieme, 1930.

MEDICAL ANNUAL, 1932. Bristol, Eng., John Wright and Sons, 1932.

RHEUMATOID ARTHRITIS AND ITS TREATMENT. By Vincent Coates and Leo Delecati. London, H. K. Lewis, 1931.

SIGN (THE) OF BABINSKI. A STUDY OF THE EVOLUTION OF CORTICAL DOMINANCE IN PRIMATES. By John F. Fulton and Allen D. Keller. Springfield, Ill., Charles C. Thomas, 1932.

UNSPECIFISCHEN CHRONISCHEN ERKRANKUNGEN (DIE) DER WIRBELSÄULE. By Hans Burckhardt. Stuttgart, Ferdinand Enke, 1932.



PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D., AND LOYAL DAVIS, M.D.

EIGHTH INSTALLMENT

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CHAPTER XXIV

THE ULNAR NERVE

In civil life the ulnar nerve may be injured as a result of pressure during sleep, especially during an alcoholic debauch. However, this occurs less frequently than does the same injury to the radial nerve. Similarly, it may be affected during the administration of a general anesthetic. Injuries and fractures and dislocations about the elbow, and callus formation, frequently produce ulnar paralysis. At times the paralysis occurs many years after the initial injury and is known as tardy or late ulnar palsy. Cases of this kind have been known to occur forty-four years after the initial injury. Dislocation and fracture of the humerus, arthritis of the cervical spine, cervical ribs, tumors and other diseases in the supraclavicular region produce paralysis of the ulnar as well as the median nerve. Occupational paralysis may often be found among watchmakers, cigar makers, metal workers, telephone operators and tailors. Occasionally the ulnar nerve alone may be affected by lead poisoning. It may be the seat of a mononeuritis following typhus, malaria or influenza. It is seldom the seat of a tumor.

In the War, injuries to the ulnar nerve were very frequent. The statistics vary, inasmuch as in some instances injuries to the brachial plexus involving the ulnar nerve were classified as ulnar nerve, or combined ulnar and median nerve injuries. In some instances the injuries constituted 18.5 per cent (Wexberg); in others, 16.7 per cent (Lehmann) of the total number of peripheral nerve injuries.

MOTOR SYMPTOMS

Section of the ulnar nerve should produce inability to flex the proximal or distal phalanges of the ring and little fingers, to abduct or adduct the fingers, to extend the second and distal phalanges of any of the fingers, to adduct the thumb,

to contract the flexor carpi ulnaris and to abduct or oppose the little finger.

When paralyzed, the appearance of the hand is quite char-



FIG. 186. Typical clawed-hand appearance in ulnar nerve paralysis.

acteristic (Fig. 186). First, there is noticed an atrophy which at times is very marked in the first dorsal interosseous space and to a lesser degree in the other spaces. Second, there is noticed a claw hand which results from the unopposed action of the extensor communis digitorum. Sometimes clawing may be plainly seen in the little finger but can hardly be observed in the ring finger, yet at times the middle finger is clawed as

well. The hypothenar eminence shows considerable atrophy and palpation gives an impression of a hollow rather than an eminence. Atrophy of the adductor of the thumb may be

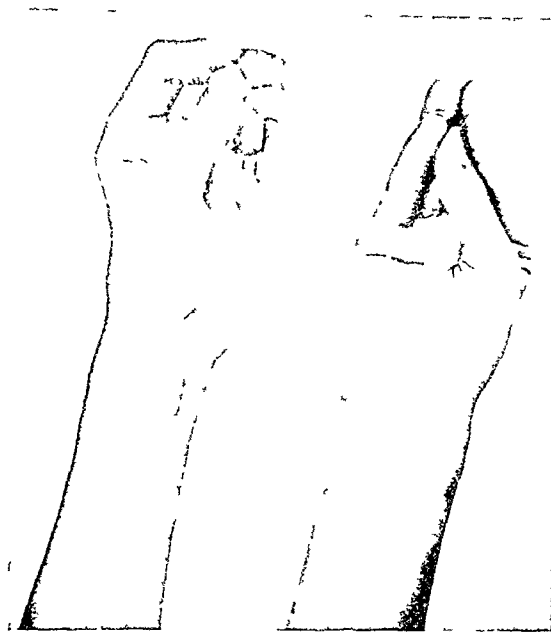


FIG. 187. Inability to oppose all of finger tips in ulnar nerve paralysis. Compare with normal hand on right.

made out at the inner part of the thenar eminence. The little finger stands off from the ring finger.

Despite such supplementary movements as will be described, the patient is unable to oppose the little finger to the thumb, to move the middle finger laterally the palm being flat on a table and the wrist immobilized, or to form a cone with the fingers and thumb (Fig. 187).

Paralysis of the flexor carpi ulnaris may be made out by inspection and palpation of the flexors of the wrist when the patient flexes the wrist against resistance. Paralysis of the flexor profundus of the little and ring fingers can be demonstrated by the imperfect flexion of the ring and little fingers in making a fist. The flexion produced at the metacarpophalangeal and second interphalangeal joints results from the influence exerted upon all segments of the finger when the flexor sub-

limis contracts. Flexion of the distal phalanges of these fingers often is practically nil.

Paralysis of the hypothenar muscles is shown by an in-

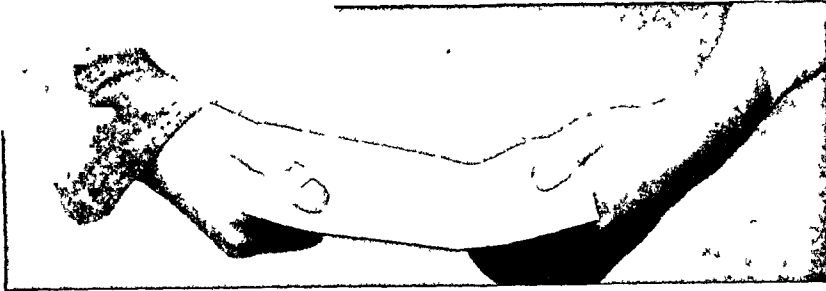


FIG. 188. Froment's newspaper sign in ulnar nerve paralysis. Note flexion of distal phalanx of thumb on right.

ability to flex the proximal phalanx of the little finger, the distal phalanges being extended. Paralysis of the interossei and of the inner two lumbricales produces the characteristic claw hand. Although all the interossei may be paralyzed, there is complete clawing only of the fourth and fifth fingers and sometimes of the middle finger. The reason for this is clear, inasmuch as the first two lumbricales which are supplied by the median nerve are unparalyzed. Extension of the distal phalanges is very feeble in the index and middle and more so in the ring and little fingers. Aside from supplementary movement, the lateral movements of adduction and abduction are lost in the middle, ring and often in the little finger.

Paralysis of the adductor pollicis and of the inner head of the flexor brevis pollicis produces defects in prehensile movement, attention to which has been drawn by Duchenne and by J. Froment. If the patient is asked to grasp any object between his thumb and index finger, such as a folded newspaper, and told to hold it tightly he vigorously flexes the second phalanx of the thumb and presses the tip awkwardly against the outer margin of the first phalanx of the index finger. This is Froment's "sign of the newspaper" (Fig. 188).

SUPPLEMENTARY MOVEMENTS: Flexion of the distal and proximal phalanges of the ring and little fingers is performed by the two inner tendons of the flexor profundus digitorum



FIG. 189. Extension of distal phalanges of index and middle fingers in ulnar nerve paralysis by supplementary muscle movement.

and the two inner lumbricales respectively. Imperfect flexion of those phalanges may result from the influence exerted on all segments when the flexor sublimis digitorum contracts. This is more marked in the little than in the ring finger. Slight flexion of the proximal phalanx of the ring finger may be obtained from the contraction of the flexor profundus digitorum pulling on the lumbrical muscles which have part of their origin from the tendon of the profundus. Although the interossei which extend the second and third phalanges of all fingers are paralyzed, inability to extend these phalanges in the index and middle finger is rare (Fig. 189). Bénisty attributes this to the preservation of the lumbricales, which she states extend the second and third phalanges, and the interossei. With this MacKenzie disagrees and he is inclined to believe that the dorsal interossei for the index and middle

fingers receive some of their nerve supply from the median. Besides this, he believes that with hyperextension of the proximal phalanx, there is an alteration in the line of pull of the interossei which become angular instead of straight and that an extended proximal phalanx forms a rigid dorsal support for the sublimis tendon, thus increasing its flexion pull. Therefore, paralysis of the lumbricales alone would produce at one time overaction of flexion of the second phalanx and a poor mechanical principle for extension of the distal phalanges. Other factors, however, enter into the production of extension of the second and third phalanges of the index and middle fingers. Duchenne, Bénisty and MacKenzie contend that the extensor communis digitorum does not produce extension of these phalanges. On the other hand, Beever pointed out that although it was true that when the extensor digitorum was paralyzed the second and third phalanges could be extended, and when the interossei were paralyzed claw hand occurred and extension of the second and third phalanges was impossible, yet if in the latter case the third phalanges were passively flexed, the second and third phalanges could be extended. He says that it is probable that in claw hand the inability of the extensor digitorum to extend the terminal phalanges is due to its energy being expended on the first phalanges, which are not prevented from overextension by the lumbricales which are paralyzed.

The following factors enter into preservation of extension of the second and third phalanges: innervation of the first and second dorsal interossei by the median and passive extension of the second and third phalanges by flexion of the proximal phalanges, thereby shortening the interossei. If the interossei are paralyzed and the lumbricales preserved, the pull on the interossei is straight and not angular. Under these conditions, contraction of the extensor communis digitorum may exert a pull on the inert interossei and produce extension of the second and third phalanges. Some pull on these interossei may be exerted by the extensor communis digitorum even if these

conditions are absent, as may be seen in combined ulnar and median nerve lesions.

The fact that the extensor communis digitorum exerts a pull

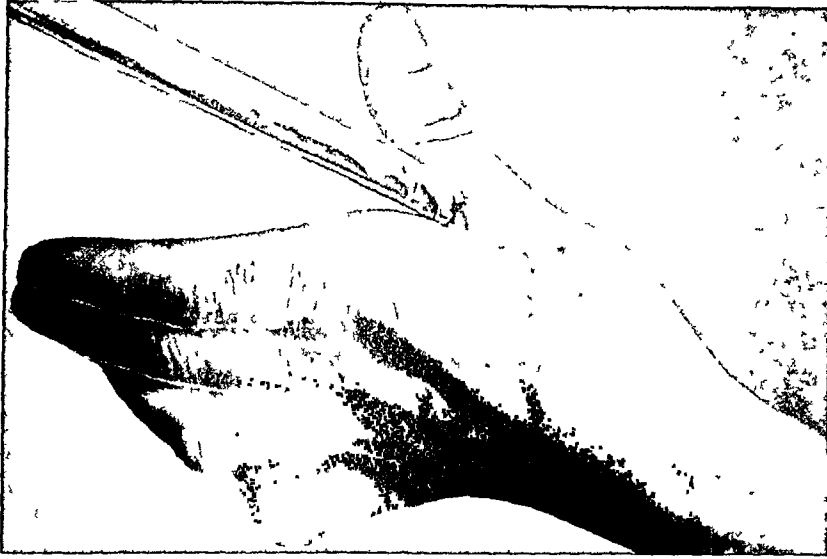


FIG. 190. Adduction of thumb by extensor longus pollicis in ulnar palsy.

on the inert interossei does not mean that it is at all concerned with the normal extension of the second and third phalanges. This function normally may be the result of an entirely independent contraction of the interossei.

In adduction of the thumb, as pointed out by Duchenne, the extensor longus pollicis is the prime mover, and in ulnar nerve lesions it may supplant the loss of the adductor pollicis (Fig. 190).

Abduction of the fingers away from the midline may result from forced extension of the first phalanges. It is very marked in the index and little fingers (Fig. 191). Slight adduction results from flexion of the first phalanges. Both of these movements have been known for a long time. The reason for the preservation of lateral movements in the middle and index fingers is given by Bénisty as the preservation of the lumbricales, as well as the extensor movement of the first phalanges. As MacKenzie points out, the lumbricales are not

concerned with lateral movements of the fingers. The preservation of lateral movements of these two fingers is due, in addition to the extensor movements of the first phalanges, to a dual

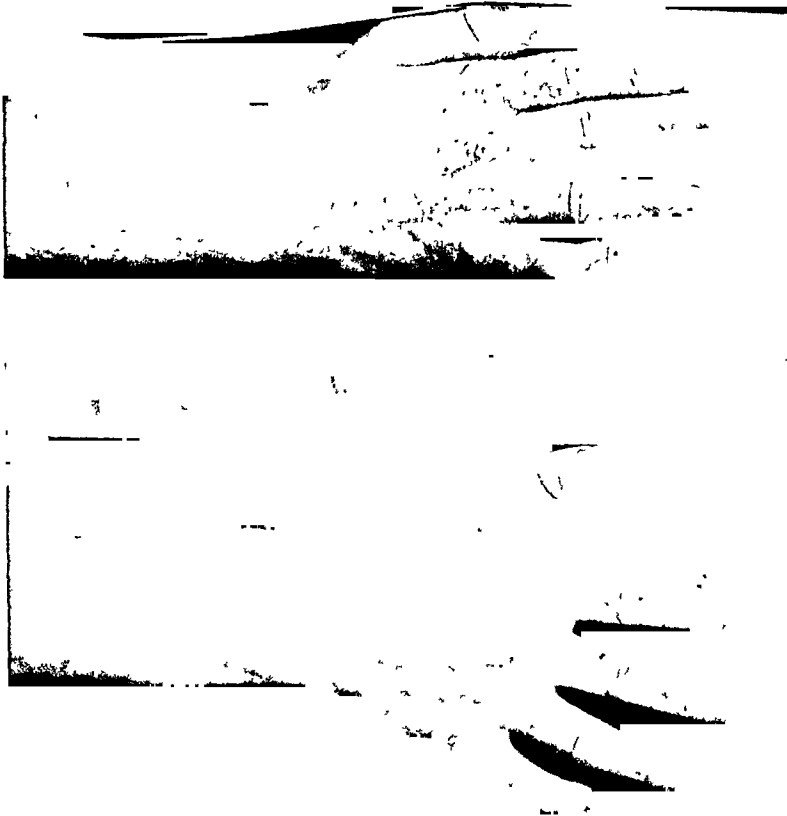


FIG. 191. Abduction of fingers by forced extension in ulnar paralysis.

nerve supply. It has been noted on a number of occasions that the first dorsal interosseus is partially preserved in complete ulnar section. Besides the abduction observed in forced extension of the first phalanx, abduction movement of the index finger can be produced by strong contraction of the abductor longus pollicis and extensor brevis pollicis. The first dorsal

interosseus, which has part of its origin on the metacarpal bone of the thumb, is pulled outward by extension of this bone and produces abduction of the index finger. When the hand is



FIG. 192. Adduction of index finger by strong contraction of extensor indicis in ulnar nerve paralysis.

abducted to the ulnar side, the tendon of the extensor indicis is so deflected that its contraction produces slight adduction of the index finger (Fig. 192).

SENSORY SYMPTOMS

In agreement with Bénisty, we have found that marked sensory loss exists even when the wound has not produced total section of the nerve. It is also marked in only partial lesions of the whole nerve. In a complete paralysis the sensory loss occupies the ulnar border of the palm, the palmar and dorsal surfaces of the little and ulnar half of the ring fingers. At times the whole ring finger and the ulnar half of the distal phalanges of the middle finger may also be involved. Stopford found that in 20 per cent of cases there were variations from the accepted sensory distribution of the ulnar nerve (Fig. 193).

The area of loss of pain and high degrees of heat and cold after overlap has been established is much smaller. Ordinarily, it may occupy the whole of the little finger. By superimposing the outlines of complete analgesia, the smallest area of analgesia in ulnar nerve lesions was found to occupy the palmar and dorsal surfaces of the little finger, extending over the

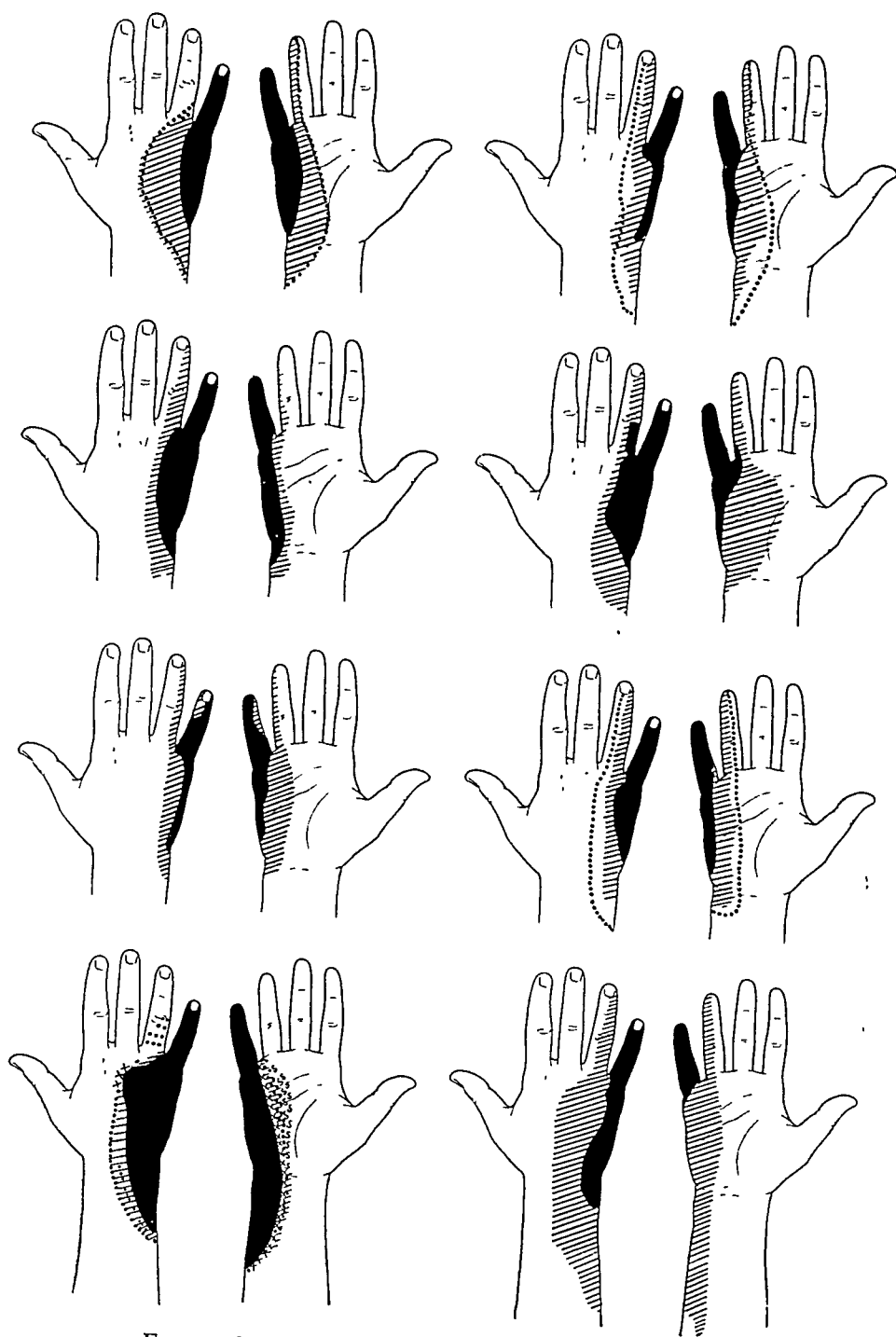


FIG. 193. Types of loss of sensation in ulnar nerve lesions.

dorsal surface of the hand in a triangular area over the fifth metacarpal bone to one-third of its length (Fig. 194). The area included between the borders of the accepted supply of the

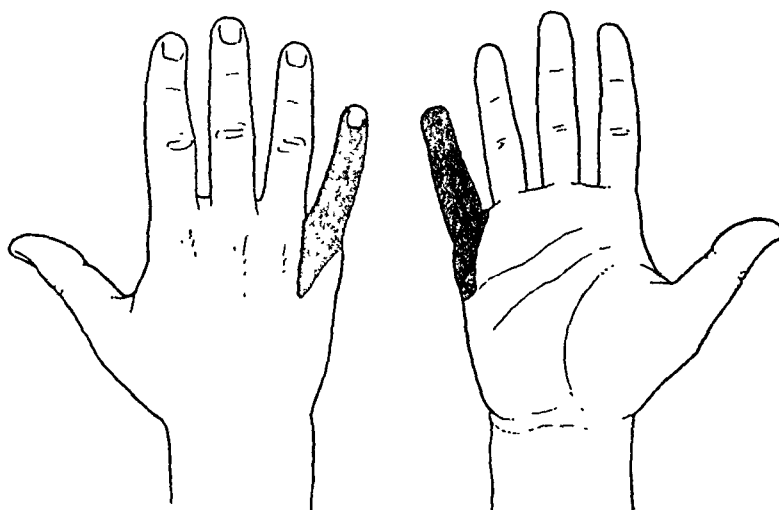


FIG. 194. Isolated supply to pain sense of ulnar nerve.

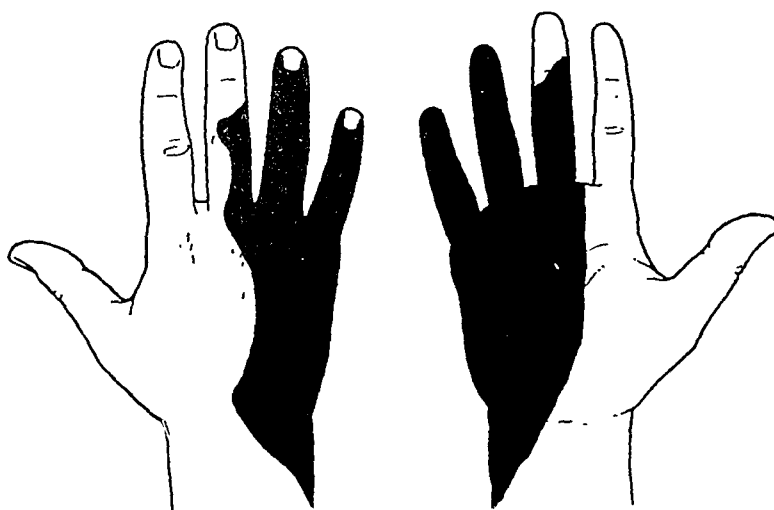


FIG. 195. Residual supply to pain sense of ulnar nerve.

ulnar nerve and the borders of this analgesia represents the possible supply of overlapping nerves to pain sense.

The area of total supply to pain of the ulnar nerve was obtained by the method of residual sensibility from a median

nerve lesion, a medial cutaneous nerve lesion and a combined median and radial nerve injury (Fig. 195). It occupies the ulnar portion of the palm to a line which is a continuation of the ulnar border of the abducted index finger, and the palmar surface of the fingers except the terminal phalanx and one-third of the ulnar part of the second phalanx of the middle finger. On the dorsal surface it occupies the ring, little and more than the ulnar half of the proximal one and one-half phalanges of the middle finger, and the dorsum of the hand to the radial border of the fourth metacarpal bone, ending proximally one inch above the wrist.

Insensibility to deep pressure or pinching is usually found only over the distal phalanx or distal two phalanges of the little finger. Bone sensibility and loss of sense of position may occur in high lesions of the nerve.

VASOMOTOR, SECRETORY, TROPHIC CHANGES

The skin over the little finger and hypothenar eminence is cold and often dry. Sometimes a purplish discoloration is seen. The skin may be thickened and the little finger nail deformed. Decalcification of the bones of the little finger may be noted. The marked muscle atrophy has already been described (Fig. 196). Ulcerations are often seen at the sites of burns produced by flicking off ashes from a cigarette or cigar (Fig. 197).

LEVEL OF THE LESION

The level of the lesion at times is the determining factor in a lesion which does not produce paralysis of all the muscles supplied by the ulnar nerve. When the lesion affects the nerve distal to a point one inch below the internal condyle of the humerus, the flexor carpi ulnaris is spared. Bénisty states that the most common type of partial paralysis is that produced by a wound in the axilla or arm, with paralysis of the interossei and hypothenar muscles and paresis of the flexor profundus and flexor carpi ulnaris.

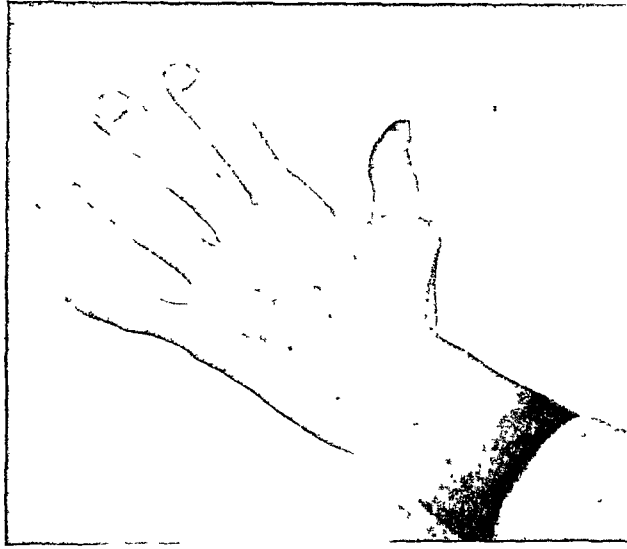


FIG. 196. Marked muscle atrophy in ulnar nerve lesion.



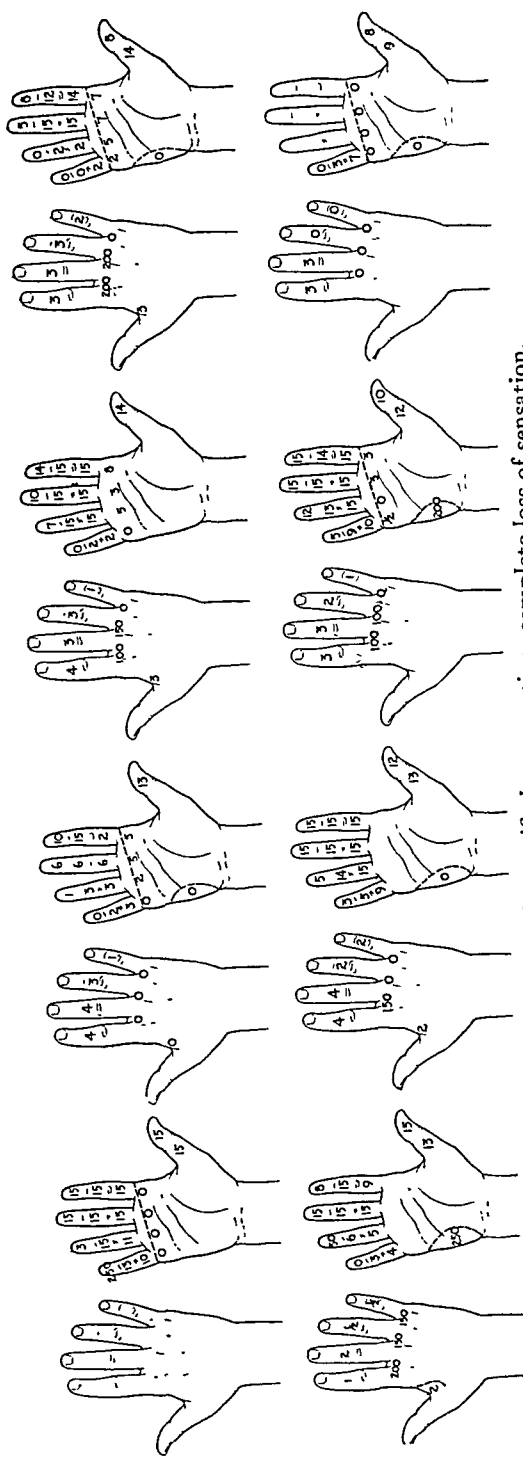
FIG. 197. Ulcerations of little finger in ulnar nerve paralysis.

In the cases observed soon after injury, of 11 in which the injury occurred in the arm, all muscles were weak only in 5 cases; the hypothenar were paralyzed in 4 cases, the interossei in 2 cases, and all muscles were paralyzed in one case. In 17 cases in which the injury was in the forearm, all muscles were weak in 6 cases, the hypothenar group was paralyzed in 4, the interossei in 3, all muscles were paralyzed in 3 cases and the adductor of the thumb and the flexor of the wrist in one each. It may be seen, then, that whether we are dealing with a lesion in the arm or in the forearm, the same order of frequency of paralyzed muscles exists. Those muscles paralyzed most frequently were, as noted by Bénisty, the hypothenar group and the interossei.

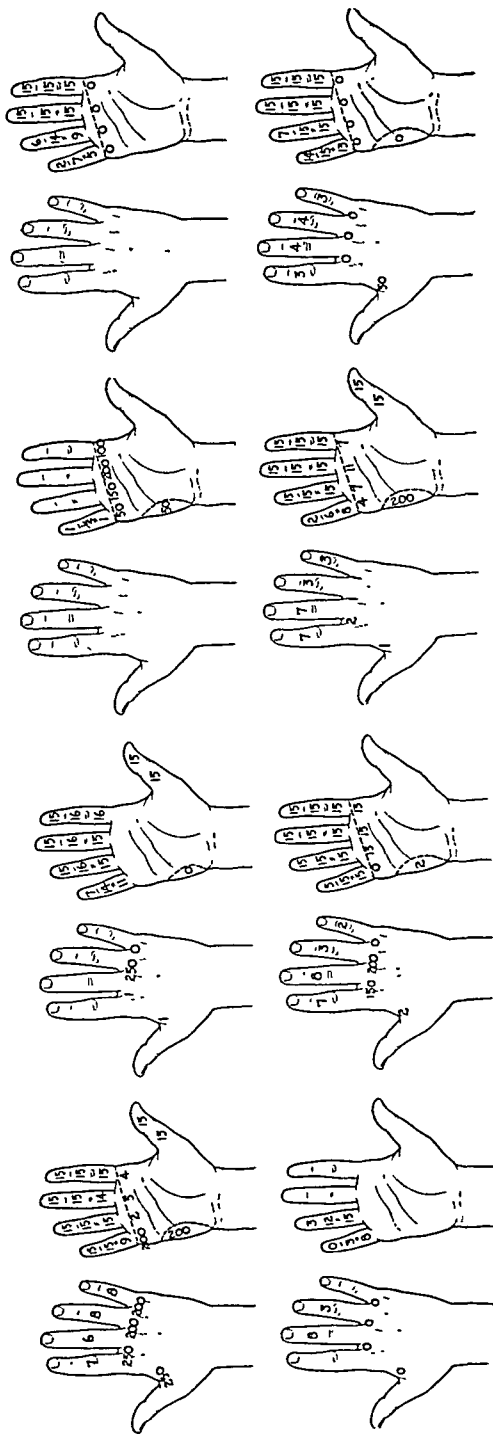
When there is a severe lesion of the ulnar nerve in the forearm or wrist below the level of the branching of the fibers and the flexor carpi ulnaris and flexor profundus digitorum, clawing is greatly exaggerated. Conversely, when the flexor carpi ulnaris and flexor profundus digitorum are only partly paretic but little clawing may be seen.

PARTIAL LESIONS

In recovering and partial lesions relatively greater strength in the phalanges is observed but may at times be an inaccurate guide to the severity of the lesion. Relatively greater strength in the abductor of the little finger, is an accurate guide as to the incompleteness of a lesion. Of course, any movement of the flexor carpi ulnaris or adductor of the thumb which is not supplementary in character determines an incomplete lesion. Of 16 partial or recovering lesions, 12 showed motor phenomena indicative of the severity of the lesion. In 9 severe cases not due to anatomic section, the motor phenomena were suggestive of partial lesion in 5 but conclusive in none. Physiologic interruption cannot be differentiated from anatomic section by the strength of movements of the phalanges of the fingers (Fig. 198).



A. Anatomical section verified at operation; complete loss of sensation.



B. Severe lesion, not anatomical section; complete loss of sensation.
 FIG. 198. Dynamometric chart of small hand muscle movements in ulnar nerve paralysis.

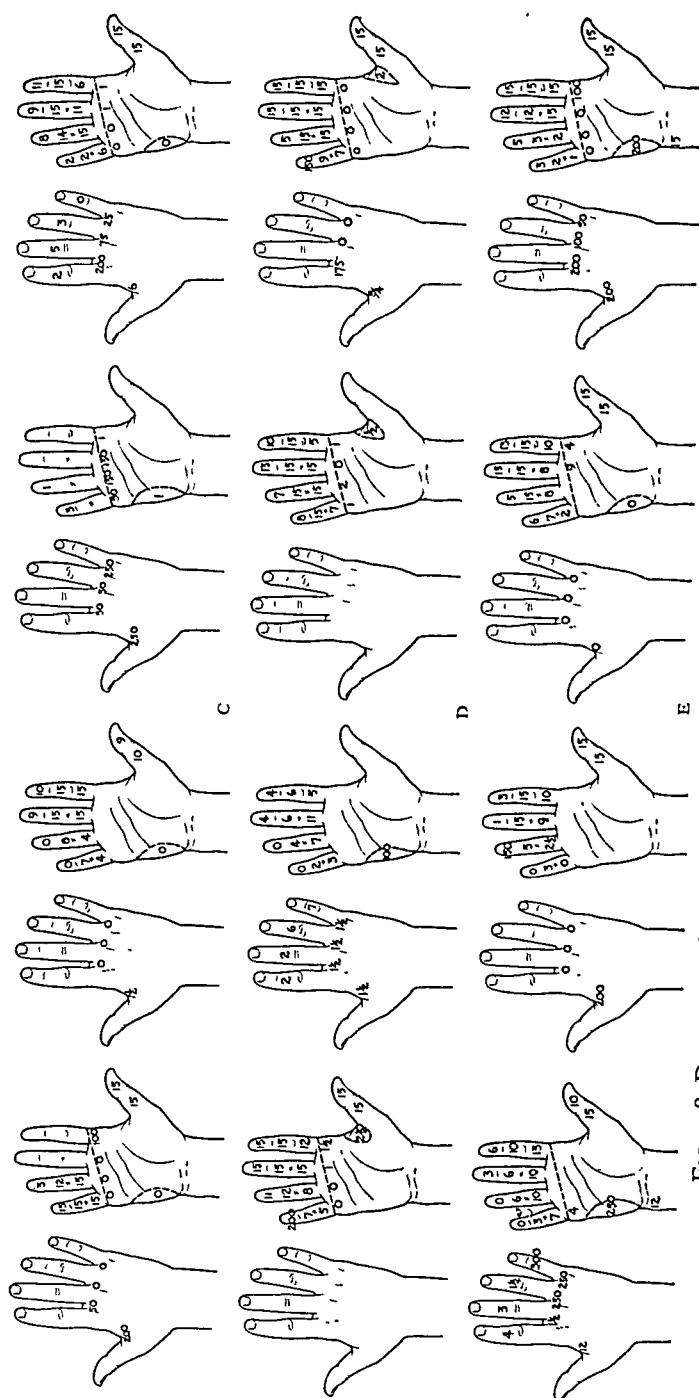


FIG. 198. Dynamometric chart of small hand muscle movements in ulnar nerve paralysis.

C. Compression of ulnar nerve, verified at operation; sensory loss partial.

D. Partial and recovering lesion not verified by operation; complete sensory loss.

E. Cases similar to D with some sensory regeneration. (Only four cases showed sensory regeneration in absence of motor recovery.)

Of 16 cases of recognized partial or recovering lesions, 11 showed incomplete sensory loss. Sensation was completely lost in all severe partial lesions. When sensory regeneration had occurred, usually motor recovery could likewise be demonstrated.

SIGNS OF MOTOR RECOVERY

The order of recovery in ulnar nerve lesions is given by Bénisty as flexor carpi ulnaris, flexor profundus digitorum and, lastly, the small hand muscles which recover very slowly. The Committee upon Injuries of the Nervous System of the Medical Research Council stated that a better functional recovery is to be expected in the flexor carpi ulnaris, flexor profundus digitorum and in the abductor *minimi digiti* than in the other muscles.

It was pointed out before that because of supplementary motility the strength of movement of the phalanges was a misleading sign of recovery. Because of this, the cases seen some months after injury were analyzed from the standpoint of residual paralysis. Of 12 recovering cases of arm injury the hypothenar group was paralyzed in 8 cases, the interossei in 4 cases, the flexor carpi ulnaris in 2, the adductor of the thumb in 2 and all muscles in one case. In 14 cases of injury in the forearm, the interossei were paralyzed in 12 cases, the hypothenar in 9 cases, the adductor of the thumb in 4 cases and all muscles were weak in one case.

In another series it was noted that of 21 cases, in which movement had returned in the small hand muscles, the adductor of the thumb had recovered in 4 cases and the abductor of the little finger in 3 cases.

This is in general agreement with the authors just quoted, in that recovery occurs most regularly in the flexor carpi ulnaris and late in the small hand muscles; but that the adductor of the thumb recovered more frequently than the abductor of the little finger.

Complete recovery may be shown by the following sign which has been described by Pitres. With the palm placed flat upon the table and the fingers abducted, the patient can



FIG. 199. Pitres' test of recovery in ulnar nerve palsy.

move the little finger inward and outward and then scratch the top of the table with the nail of his little finger without moving his wrist (Fig. 199).

SIGNS OF SENSORY RECOVERY

Ulnar nerve lesions in general showed a larger number of cases in which there was but little sensory recovery when motor recovery had begun.

In those cases which recovered spontaneously, recovery of pain sense as well as diminution of degree of analgesia in the isolated sensory supply of the nerve was frequently noted. Return of pain and touch in patches occurred. Areas of return of pain and cold and persistent anesthesia to touch were noted. Almost complete return of sensation to cold, with anesthesia and analgesia was observed. In the cases which recovered following operation the loss to pain sense was generally greater but the same general characteristics were found. Particularly interesting were the areas of recovery of tactile sense in indentations and fissures (Figs. 200, 201).

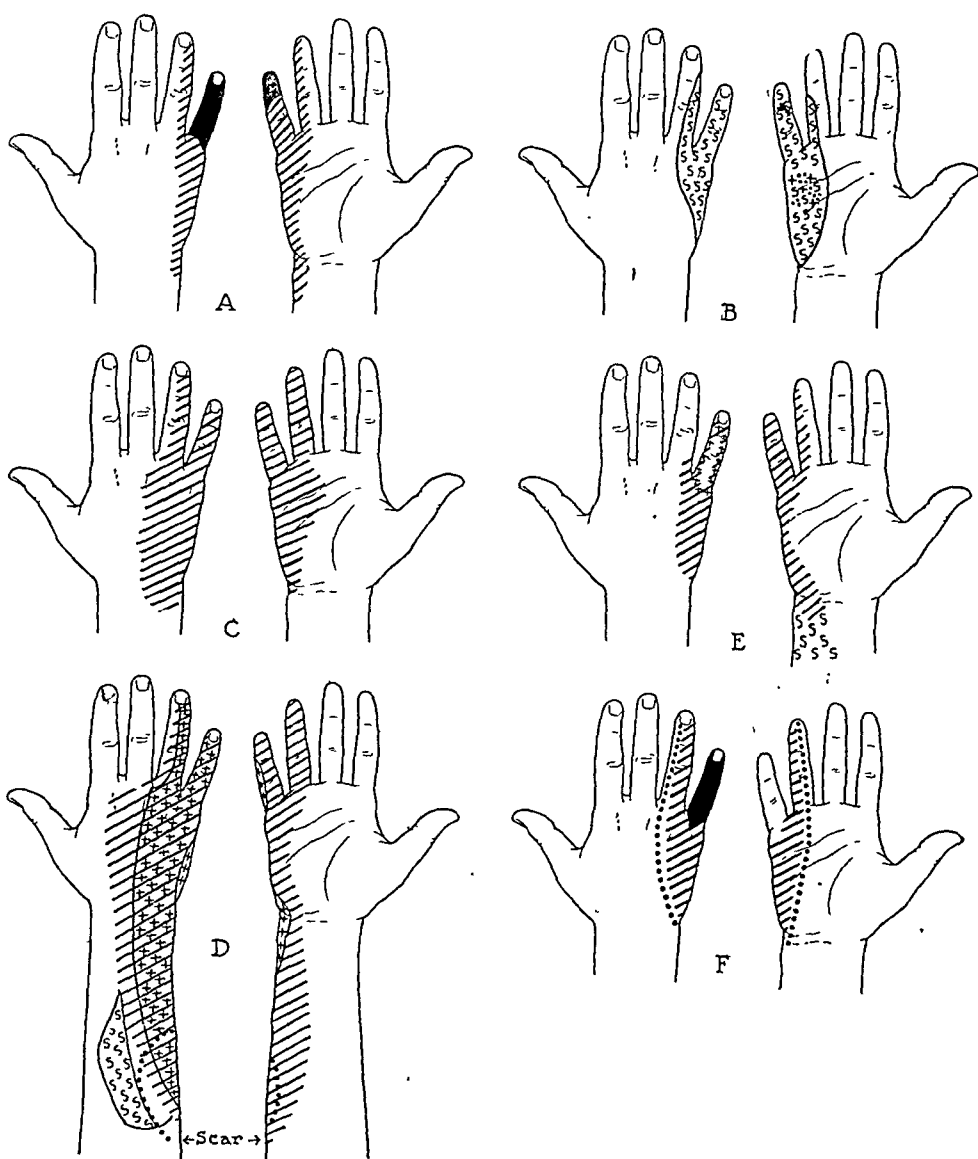


FIG. 200. Sensory loss of ulnar nerve lesions spontaneously recovering.

A. Rare severe lesion with marked sensory loss. B. Recovery of pain in isolated supply, diminished loss of touch. C. Recovery of pain. D. Recovery of pain in isolated supply, recovery of cold. E. Recovery of patch of pain and touch.

DIFFERENTIAL DIAGNOSIS

In civil life paralysis of the ulnar nerve must be distinguished from such lesions of the spinal cord as anterior

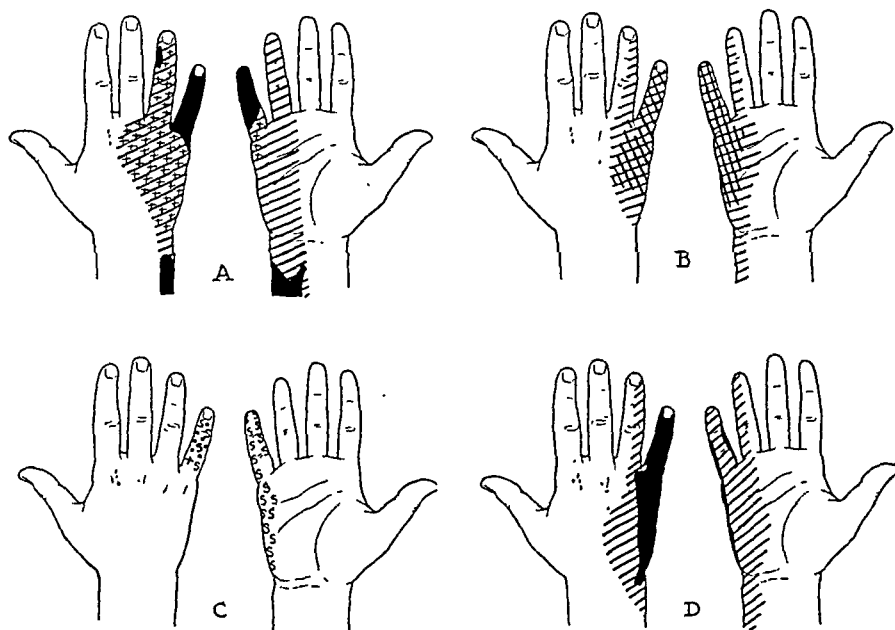


FIG. 201. Extensive loss of ulnar nerve lesions following operation. A. Extensive sensory loss, motor recovery. B. Diminished loss of pain. C. Patchy recovery of touch and complete recovery of pain. D. Recovery of pain in isolated supply of nerve.

poliomyelitis, syringomyelia, intramedullary tumors, meningo-myelitis and progressive muscular atrophy. The lesions which affect only the anterior horns or the anterior horns and lateral columns are easily differentiated by the absence of sensory changes and the sparing of some muscles supplied by the ulnar nerve and paralysis of others not supplied by the ulnar nerve. Such disease as syringomyelia or intramedullary tumors present dissociated sensory changes and evidence of involvement of the pyramidal tracts in the lower extremity. The latter is likewise true of meningo-myelitis and extramedullary tumors.

Ischemic paralysis and Volkmann's contracture may be differentiated, as was indicated in the chapter on the Median Nerve, by the absence of sensory changes limited to the distribution of the ulnar nerve, the induration of the muscles,

vascular disturbances, and by the absence of the reaction of degeneration.

ANATOMY

The ulnar nerve arises from the inner cord of the brachial plexus and is therefore made up of fibers derived from the anterior divisions of the eighth cervical and first thoracic spinal nerves. Occasionally fibers from the seventh cervical nerve may join the ulnar. Kerr has stated that infrequently it may arise from a single root and Sterzi concludes that it is a branch from the median nerve.

In the axilla the nerve is placed rather deeply between the axillary artery and vein and lies medial to the median nerve. When the arm is abducted the nerve passes beneath the axillary vein. It follows along the internal border of the artery which separates it from the median nerve. The musculocutaneous nerve lies more anteriorly and laterally; the medial cutaneous nerves to the arm and forearm are medial to the ulnar and lie upon it and the axillary vein. The radial nerve lies behind the artery and is therefore external and posterior to the ulnar. The ulnar nerve leaves the axilla, from beneath the pectoralis major muscle, lying upon the surface of the teres major and latissimus dorsi muscles.

In the upper third of the arm the internal intermuscular septum, upon which it lies, separates the ulnar from the triceps muscle. As the nerve descends the brachial artery still lies anterior and external. The median nerve is more anteriorly placed at the external side of the artery. The radial still lies posterior and external but is in closer relation to the ulnar. The nerve follows the internal bicipital groove formed by the biceps muscle in front and the brachialis anticus muscle behind. In slender individuals it can be palpated through the skin, thin aponeurosis and subcutaneous tissue. At a level between the middle and inferior thirds of the arm the ulnar pierces the median intermuscular septum and the inner head of the triceps to reach a plane posterior to the medial condyle

of the humerus. Just above the medial condyle the nerve enters a groove behind the humerus. It is accompanied by the inferior profunda artery and is covered posteriorly by an aponeurosis which extends between the olecranon and the medial condyle. In this aponeurosis are transverse and longitudinal fibers which are the remains of the rudimentary epitrochleo-anconeus muscle, and which receive a small branch from the ulnar. Gegenbaur has described a bursa which separates the nerve from the internal lateral ligament and which allows free movement of the nerve during flexion and extension of the forearm.

The nerve reaches the forearm by passing between the two heads of origin of the flexor carpi ulnaris muscle. As the ulnar lies in the groove of the medial condyle it is joined by the posterior ulnar recurrent artery and vein which lie externally. The artery anastomoses with the inferior profunda which has accompanied the ulnar nerve from above. In the forearm the nerve lies upon the flexor digitorum profundus muscle and is covered by the flexor carpi ulnaris. It becomes more and more superficial lying in the cleft between the flexor digitorum sublimis and the flexor carpi ulnaris. In the upper third of the forearm the ulnar artery and its accompanying veins join the nerve lying externally to it (Fig. 202). The ulnar reaches the level of the anterior annular ligament, passes through a special canal in this structure upon the radial side of the pisiform bone and reaches the palm of the hand where it breaks up into its terminal branches (Fig. 203). The ulnar nerve gives off no branches in the arm. About 4 cm. above the medial condyle of the humerus an *articular* branch arises. This branch and its ramifications pass horizontally and externally to become lost within the capsule of the elbow joint.

At a slightly lower level below the bend of the elbow *muscular* branches are supplied to the flexor carpi ulnaris and the inner half of the flexor digitorum profundus muscles. The flexor carpi ulnaris receives a branch as the nerve passes between its two heads of origin. It also receives innervation

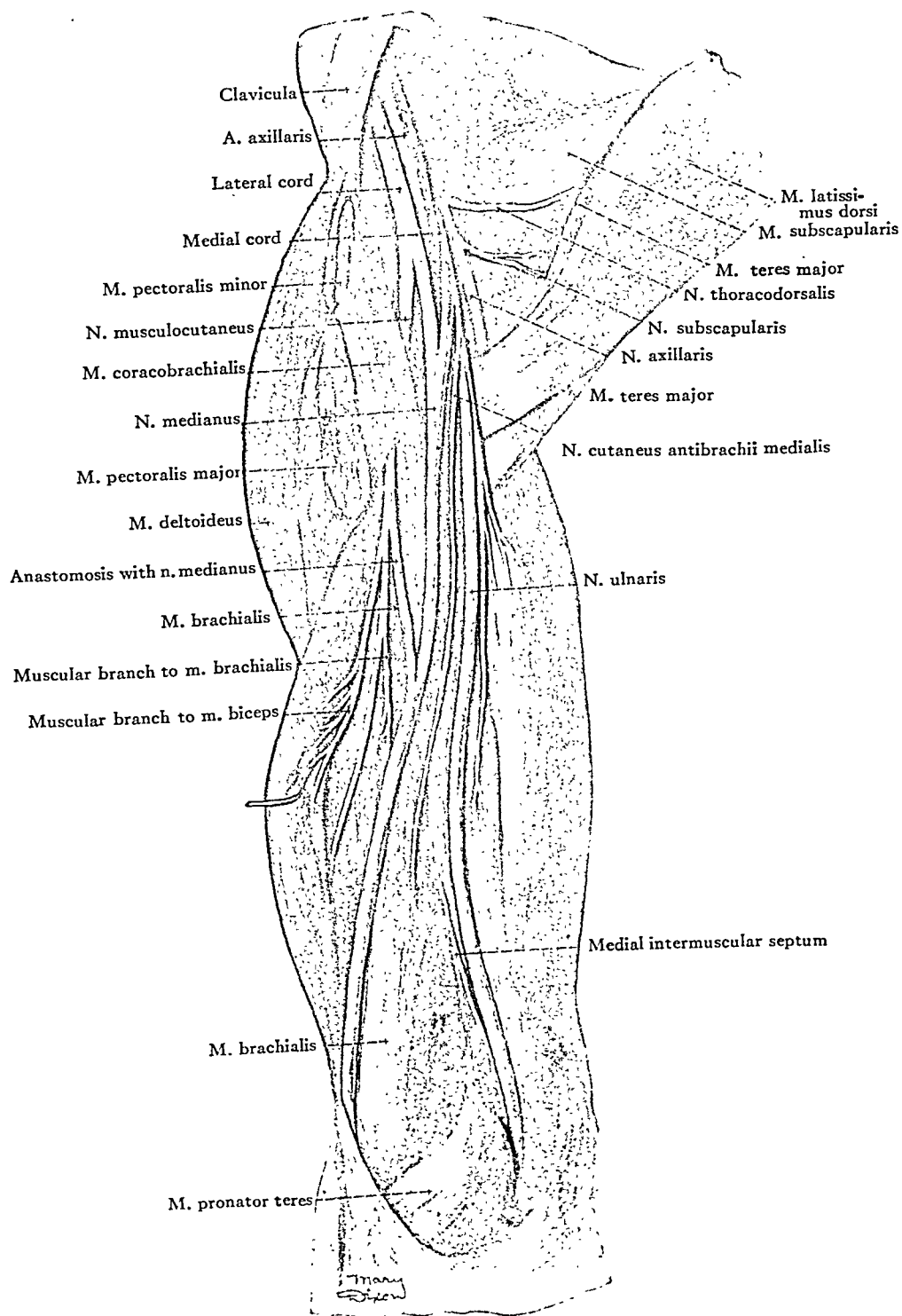


FIG. 202. Anatomical course of ulnar nerve in axilla and upper arm.

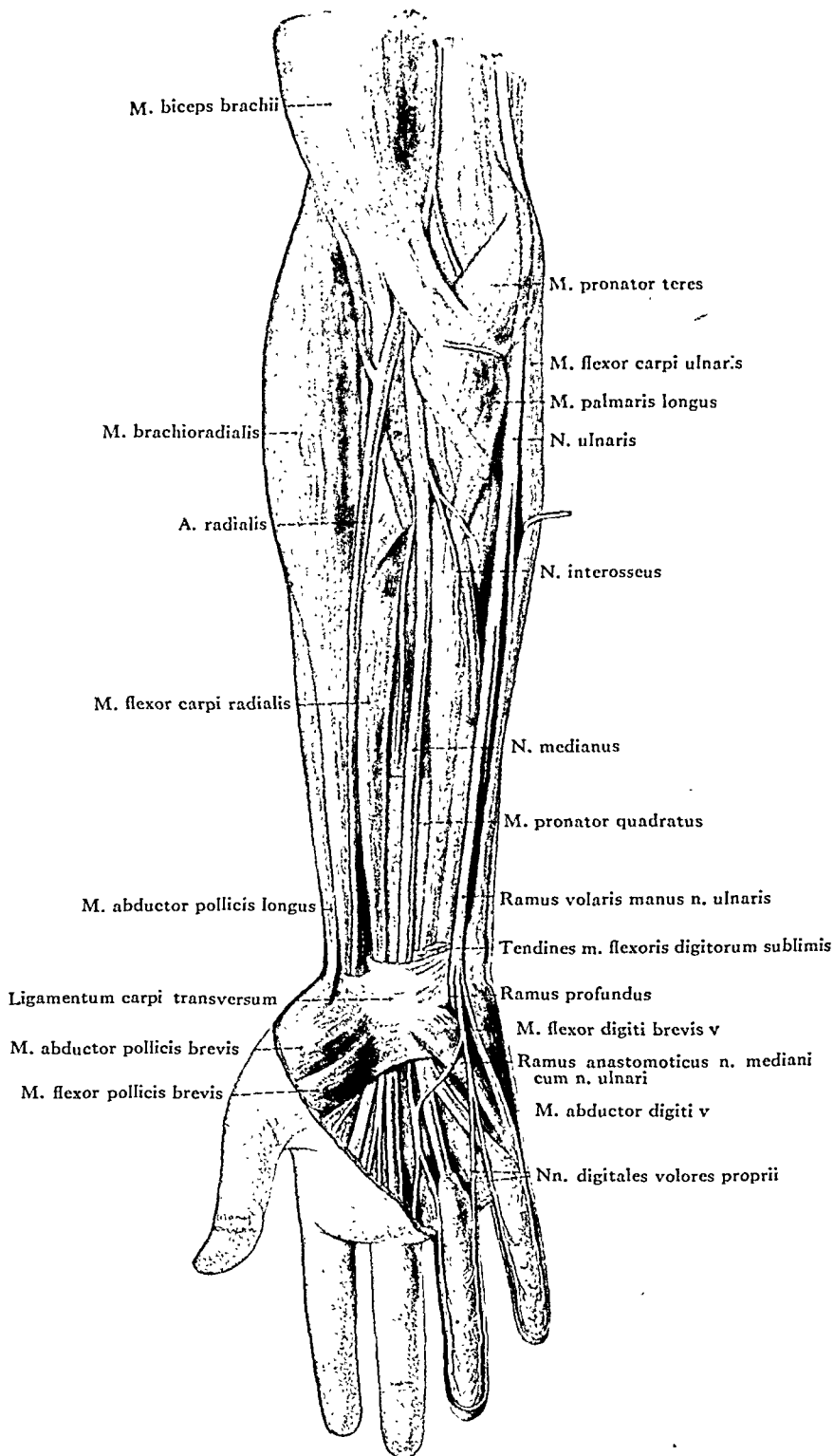


FIG. 203. Anatomical course of ulnar nerve in forearm, wrist and hand.

in its middle third and from the ulnar or from the branch to the flexor digitorum profundus. The latter muscle receives two branches from the ulnar in the upper third of the course of the nerve in the forearm. They are larger than the branches to the flexor carpi ulnaris.

A large *dorsal cutaneous branch*, which may be mistaken for the parent ulnar trunk, arises at the junction of the middle and lower third of the nerve in its course in the forearm. It descends beneath the tendon of the flexor carpi ulnaris muscle and passes posteriorly to reach the dorsal surface on the inner aspect of the hand. This branch supplies sensation to the dorsal surface of the little finger and part of the dorsal aspect of the ring and middle fingers. This branch may arise from the ulnar trunk just below the medial condyle or as low as the styloid process (Henle, Krause). A slender *branch to the ulnar artery* arises in the middle third of the trunk of the nerve. It accompanies the vessel into the palm where it anastomoses with a digital branch of the median.

After the ulnar passes through the canal in the anterior annular ligament it breaks up into its two *terminal branches*. The *superficial branch* which crosses the flexor digiti quinti brevis muscle after a short course divides into three terminal branches. One of these ramifications innervates the small palmaris brevis muscle which lies in the skin of the hypothenar eminence. The two other branches are sensory in function. One passes distally across the palmar surface of the hand to become the digital nerve on the ulnar aspect of the little finger. The other gives off a twig to join the digital branches of the median and then continues distally to end as the digital nerve to the ulnar aspect of the ring finger and the radial surface of the little finger.

The *deep branch* is entirely muscular in its supply. It passes toward the radial side of the palm between the abductor and flexor digiti quinti muscles. It lies deeply in close relation to the deep palmar arterial arch. It supplies all of the muscles of the hypothenar eminence, the two inner lumbricales,

and all of the palmar and dorsal interosseous muscles. It ends by supplying the adductor pollicis muscle and the inner head of the flexor brevis pollicis, where its twigs may anastomose with those of the median which supply the outer head of the flexor brevis pollicis.

PHYSIOLOGY

Most of the muscles of the hand are supplied by the ulnar nerve. The *flexor carpi ulnaris* muscle flexes the wrist and draws it ulnarward. It does not adduct the wrist. The *two inner heads* of the *flexor digitorum profundus* flex the second and the terminal phalanges of the ring and little fingers. There are seven *interosseous* muscles; four *dorsal* and three *palmar*, all of which are innervated by the ulnar nerve. The interossei produce flexion at the metacarpophalangeal joints and extension of the second and terminal phalanges. They also abduct and adduct the fingers. The *lumbricales* also flex the metacarpophalangeal joints. There are four muscles in the hypothenar eminence: the *palmaris brevis*, *abductor minimi digiti*, *flexor brevis minimi digiti*, *opponens minimi digiti*. The abductor minimi digiti draws the little finger toward the ulnar side of the hand. It also aids the flexor brevis minimi digiti to produce flexion at the metacarpophalangeal joint of the little finger. The opponens minimi digiti draws the fifth metacarpal bone forward and outward.

The *adductor pollicis* and the inner head of the *flexor brevis pollicis* have an analagous action. They flex slightly the first phalanx of the thumb, tilt its inner border and rotate it on its long axis. The result is that the metacarpal of the thumb is drawn outward and in front of the second metacarpal. These muscles also extend the second phalanx of the thumb upon the first. When they are fully contracted the first metacarpal bone is on a level with the second, the second phalanx is extended and the first phalanx is closely applied to the outer border of the metacarpophalangeal joint of the first finger.

SURGERY

An isolated injury to the ulnar nerve in the axilla is rarely found. A combined lesion of the terminal portion of the brachial plexus or of the ulnar with the median or radial is of more common occurrence. As the ulnar leaves the axilla it passes across the tendon of the latissimus dorsi muscle in close relation to the radial and both nerves commonly suffer simultaneous injury.

The nerve is exposed by dissecting free the axillary vein and retracting it either inward or outward, whichever may be the most convenient. If there is a great amount of scar tissue present, the pectoralis major muscle should be divided and retracted inward so that the fatty substance in the axilla may be freed from the axillary vein and displaced toward the chest wall. The intercostobrachial and medial cutaneous nerve to the arm may be divided. If the ulnar is bound by scar tissue to the posterior wall of the axilla, it may be necessary to divide the subscapular artery in a manner similar to that used in dissecting the axilla free from malignant disease. In so doing the nerve to the latissimus dorsi muscle (subscapular) should be preserved. If the ulnar is involved close to its origin from the brachial plexus, a concomitant injury of the median is not uncommonly found. Both nerves may require suture to the inner cord of the brachial plexus.

To prepare the patient with an ulnar nerve lesion in the arm the arm is abducted to a right angle to the body and the elbow and forearm are supported by a sandbag.

A long incision is made parallel to the neurovascular bundle in the groove between the biceps and triceps muscles where these structures can be palpated in slender individuals (Fig. 204). At the junction of the middle and lower thirds of the arm the incision should be directed posteriorly, following the intermuscular septum, to the medial condyle of the humerus.

The neurovascular bundle should be opened after it is exposed by dividing the deep fascia. The ulnar should be

identified above the lesion and localization sutures should be placed in the perineurium before the nerve is completely isolated so that it is not rotated during its further exposure.



FIG. 204. Line of incision to expose ulnar nerve in arm.

Considerable difficulty may be experienced with bleeding if the neurovascular bundle is involved in dense scar tissue.

In the lower third of the arm the nerve is to be found superficially within the fibers of the triceps. Bleeding from the inferior profunda artery may interfere with the exposure unless the vessel is isolated and kept under control both from above and below. It will be remembered that the anterior and posterior ulnar recurrent arteries form a collateral circulation with the inferior profunda in this region.

As the ulnar passes behind the medial condyle of the humerus to lie in the olecranon groove it is exposed to frequent trauma. In war injuries its involvement was second only to that of the radial. It may be involved very commonly in a fracture about the elbow joint. Often the original trauma to the medial condyle or elbow joint may be slight and years later ulnar paralysis may develop. Cases have been reported in which the first signs of nerve involvement appeared thirty years or more after injury (Stookey, Hunt, Adson). In some individuals the groove for the ulnar nerve is shallow so that the nerve may subluxate frequently and thus give rise to irritative symptoms.

The position of the extremity for operation should be with the arm fully abducted and externally rotated. The incision should extend upward along the course of the nerve in the

lower third of the arm and downward into the upper forearm. It should be slightly curved with its center crossing the medial border of the olecranon (Fig. 205).

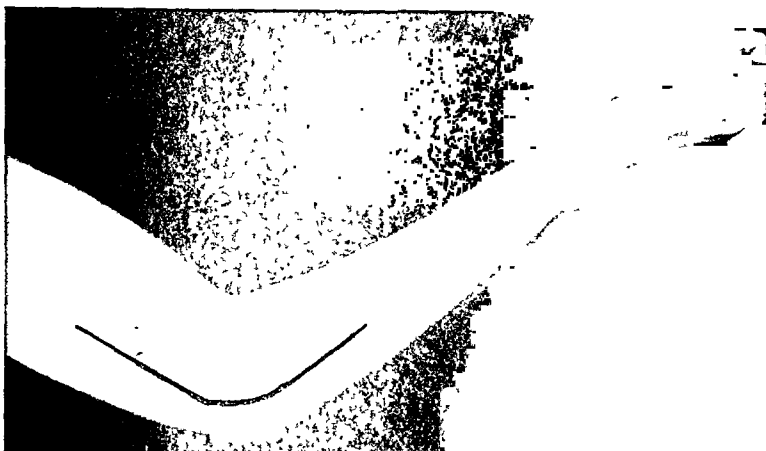


FIG. 205. Line of incision to expose ulnar nerve at elbow.

After dividing the deep fascia, the vessels already mentioned should be ligated to avoid troublesome bleeding. The ulnar collateral branch of the radial nerve, which supplies the medial head of the triceps, lies in close relation to the ulnar along the posterior border of the internal intermuscular septum and should be avoided. Leaving the olecranon groove, the ulnar will be found passing beneath the connection arch between the two heads of the flexor carpi ulnaris which may be divided to expose the nerve thoroughly. At this level it is extremely important to preserve the branches which innervate the flexor carpi ulnaris and the ulnar half of the flexor digitorum profundus muscle.

Because of irritation from repeated traumas or because of a large defect in the continuity of the ulnar which results from resection of the neuromas it may be necessary to transpose the ulnar nerve from the olecranon groove to the anterior surface of the elbow. In this way a defect of from 3 to 4 inches may be overcome, not only by shortening the course of the nerve trunk but by avoiding tension upon it by flexion of the elbow.

The incision is similar to that just described but, in addition, the anterior skin flap is reflected to expose the medial edge of the biceps muscle and its tendon. The posterior flap is undermined sufficiently to allow exposure of the fascia attached to the olecranon. The nerve is freed from its bed and if necessary the articular branches may be severed to get free mobilization. The branches to the flexor carpi ulnaris and flexor digitorum profundus may interfere with mobilization and if so they should be dissected carefully off the sheath of the parent trunk to their origin. This will obtain mobilization and still preserve these branches. The nerve is then carried anteriorly to lie on the bellies of the muscles which arise from the medial condyle. Care must be taken to prevent angulation or constriction. It may be held in place by separating the posterior deep fascia from the medial condyle, bringing it forward and suturing it over the ulnar to the anterior deep fascia. This should be done loosely enough not to constrict the nerve and yet far enough to prevent the nerve from slipping back into its original position.

If the transposition is to be done for defect in the nerve, either the central or distal end of the nerve may be transposed, depending upon the location of the injury. If the branches to the flexor carpi ulnaris and flexor digitorum profundus have been destroyed or are to be sacrificed the end to be transposed is drawn through a tunnel made by passing a closed blunt hemostat beneath the flexor digitorum sublimis and pronator teres upon the flexor digitorum profundus. This must be passed between those muscles and not through them. This transposition should be done before the neuromas are resected and care should be taken so to identify the surfaces of the cut ends of the nerve that axial rotation will not occur. If the branches to the flexor carpi ulnaris and flexor digitorum profundus muscles are sacrificed deliberately for purposes of mobilization, they should be divided close to the muscles so that after transposition of the trunk, they may be implanted into the muscles directly to secure neurotization. If this is

impossible, the tendons of the flexor digitorum profundus to the fourth and fifth fingers may be implanted into those of the second and third fingers and the palmaris longus tendon



FIG. 206. Line of incision to expose ulnar nerve in forearm.

may be sutured to the distal end of the flexor carpi ulnaris tendon. This procedure usually gives good functional results. The nerve may be transposed to lie on the surface of the flexor muscles, but if this is done 1 to 2 cm. is lost in bridging the defect.

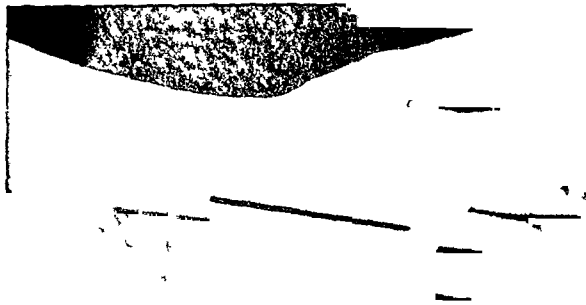


FIG. 207. Line of incision to expose ulnar nerve at wrist.

An incision from the radial side of the pisiform bone toward the medial condyle will follow the course of the ulnar nerve in the forearm (Fig. 206). It is advisable to identify the nerve near the wrist. It may be followed upward by separating the loose attachment between the flexor carpi ulnaris and the flexor digitorum sublimis. The large dorsal cutaneous branch which passes beneath the tendon of the flexor carpi ulnaris should not be confused with the parent trunk.

Lesions of the ulnar nerve in the lower third of the forearm and at the wrist are commonly associated with severance of the flexor tendons. The latter should be freed of all scar tissue and reunited. Loss in continuity because of a defect may be compensated for by flexion of the hand at the wrist and many times an end-to-end suture may be obtained in this manner. (Fig. 207.)

To expose the ulnar nerve at the wrist an incision is made along the radial border of the flexor carpi ulnaris tendon radial to the pisiform bone and into the palm in the direction of the third interspace. The anterior annular ligament is opened to expose the nerve in its special compartment. The opponens and abductor digiti quinti muscles may be separated from their origin on the uncinat bone. If they are reflected ulnarward the nerve will be exposed. In an attempt to repair the small motor or cutaneous branches of the ulnar in the hand, extreme care should be used and the difficulties of the situation should be realized. The impairment of function which might result from the necessary surgical trauma may far overshadow the original disability.

CHAPTER XXV

COMBINED MEDIAN AND ULNAR NERVE LESIONS

Concomitant injury to the ulnar and median nerves is a common occurrence. When the lesions are complete the appearance of the hand and the disturbance of function is constantly the same. If both nerves have suffered incomplete lesions, or if one is completely paralyzed and the other only partially injured, the clinical manifestations may differ widely. So many varieties of such injuries may occur as to lead to classifications which are based upon the varied appearances and functions of the hand.

MOTOR SYMPTOMS

In the case of total paralysis of both nerves the appearance of the hand is quite characteristic. The wrist is slightly hyperextended and the hand inclined to the radial side. The thumb is slightly abducted and lies in the plane of the palm, producing the appearance of an "ape hand." The first phalanges are moderately extended and slight passive flexion of the last two phalanges occurs. Marked wasting is seen in the thenar and hypothenar eminences and in the dorsal interossei. The flexor tendons of the fingers appear prominently in the palm. No flexor movements are possible except as they occur as the result of supplementary movements. No movement occurs in the little finger, and except for extension and abduction of the thumb in the plane of the palm no movement is possible in the thumb (Fig. 208).

SUPPLEMENTARY MOVEMENTS: Slight passive movement of flexion at the wrist is produced by hyperextension of the hand with sudden relaxation. Active contraction of the abductor longus pollicis assists in carrying out this movement of flexion. At times this muscle is capable of producing flexion in the absence of relaxation following hyperextension (Fig. 209). Flexion of the fingers is similarly performed by hyperextension

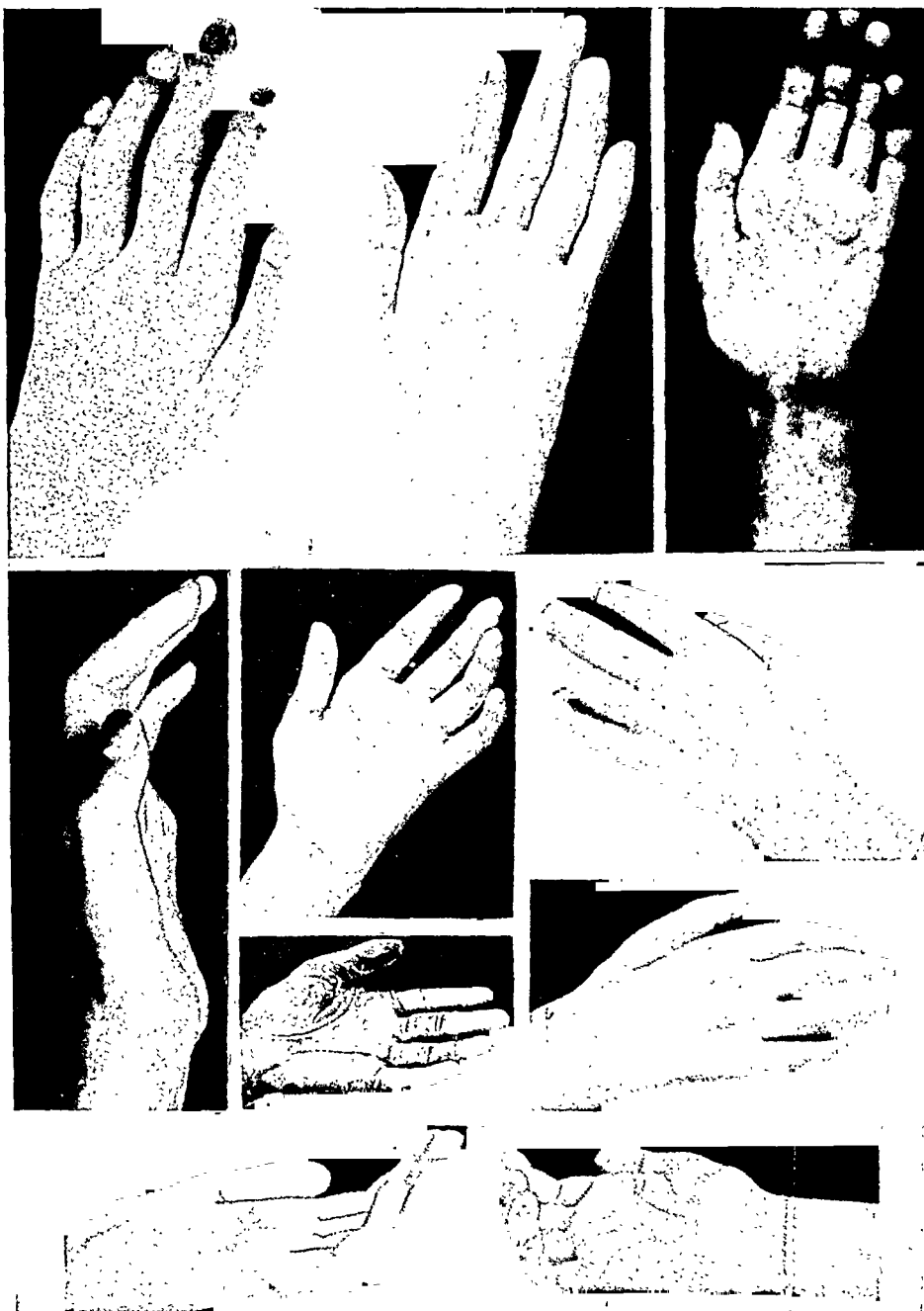


FIG. 208. Characteristic appearance of hand in combined median-ulnar nerve paralysis.

of the hand and extension of the fingers which are then suddenly relaxed. Slight abduction of the fingers may be produced by energetic contraction of the extensors.

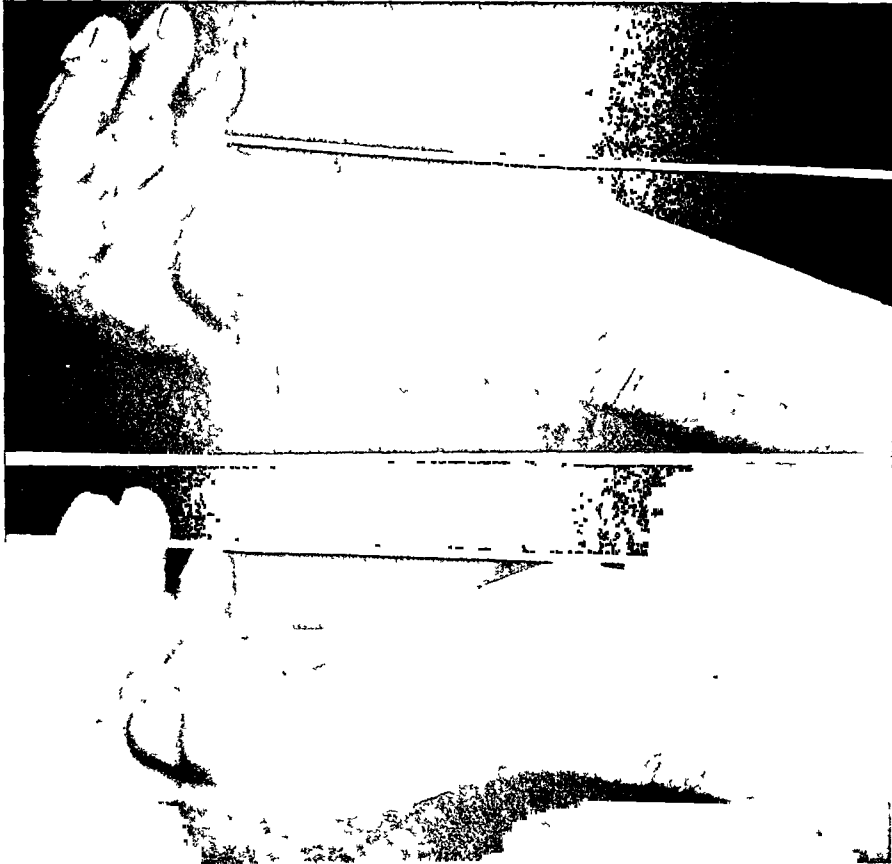


FIG. 209. Flexion of wrist by supplementary movement of extensor ossei metacarpi pollicis in median-ulnar nerve palsy.

SENSORY SYMPTOMS

The loss of sensation in combined median and ulnar nerve lesions is marked. Tactile sensibility is lost over the area which represents the sensory distribution of both nerves; that is, over the palmar and the dorsal surfaces of all the fingers, excepting the area supplied by the radial nerve and the ulnar border of the dorsum of the hand. Sensation to pain and high and low degrees of temperature is preserved over a variable

area corresponding to the overlap of the radial and musculocutaneous nerves. Usually the thumb, the radial half of the palm, the proximal phalanges of the index, middle, and part or

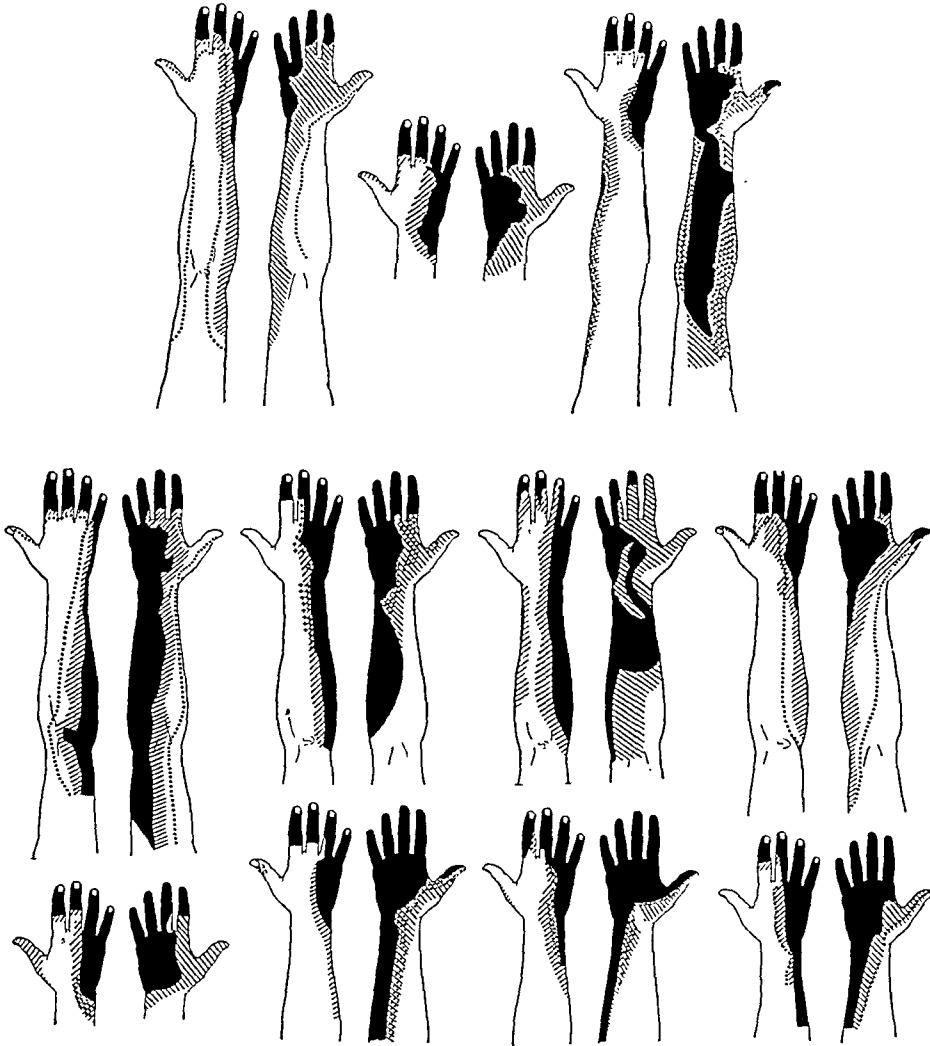


FIG. 210. Sensory loss in combined median-ulnar nerve lesions. (In some instances medial cutaneous nerve of forearm and in others medial cutaneous nerve of forearm and musculocutaneous nerve were injured simultaneously.)

all of the proximal phalanx of the ring finger, are sensitive to pin prick. There is no sensation to deep pinching over the

distal phalanges of any of the fingers. The appearance of a sensory chart showing the dissociation of sensation is characteristic and is easily distinguished from that of a partial or



FIG. 211. Trophic nail changes in combined median-ulnar nerve palsy.

recovering lesion (Fig. 210).

VASOMOTOR, SECRETORY AND TROPHIC CHANGES

These are much the same as those seen in cases of paralysis of the ulnar and median nerves alone. Changes in the nails are prominent, as are coldness, dryness and discoloration of the skin. When associated with a vascular lesion, which is common, pronounced vasomotor changes, with cyanosis, glossy skin or edema and marked deformity of the nails occur (Fig. 211).

PARTIAL LESIONS

Partial lesions of the ulnar and median nerves produce many interesting types of dissociated paralysis. A number of these have been described by Bénisty. In one type the small hand muscles and flexors of the fingers alone are paralyzed. In another there is in addition to the paralysis of the small hand muscles only a paresis of the deep flexors which produces a very marked clawing of the proximal phalanges. A number of other types have been described but their recognition is

important only in calling attention to the incomplete paralysis. Careful dynamometric studies show that when observed some time after injury anatomic section of both ulnar and median

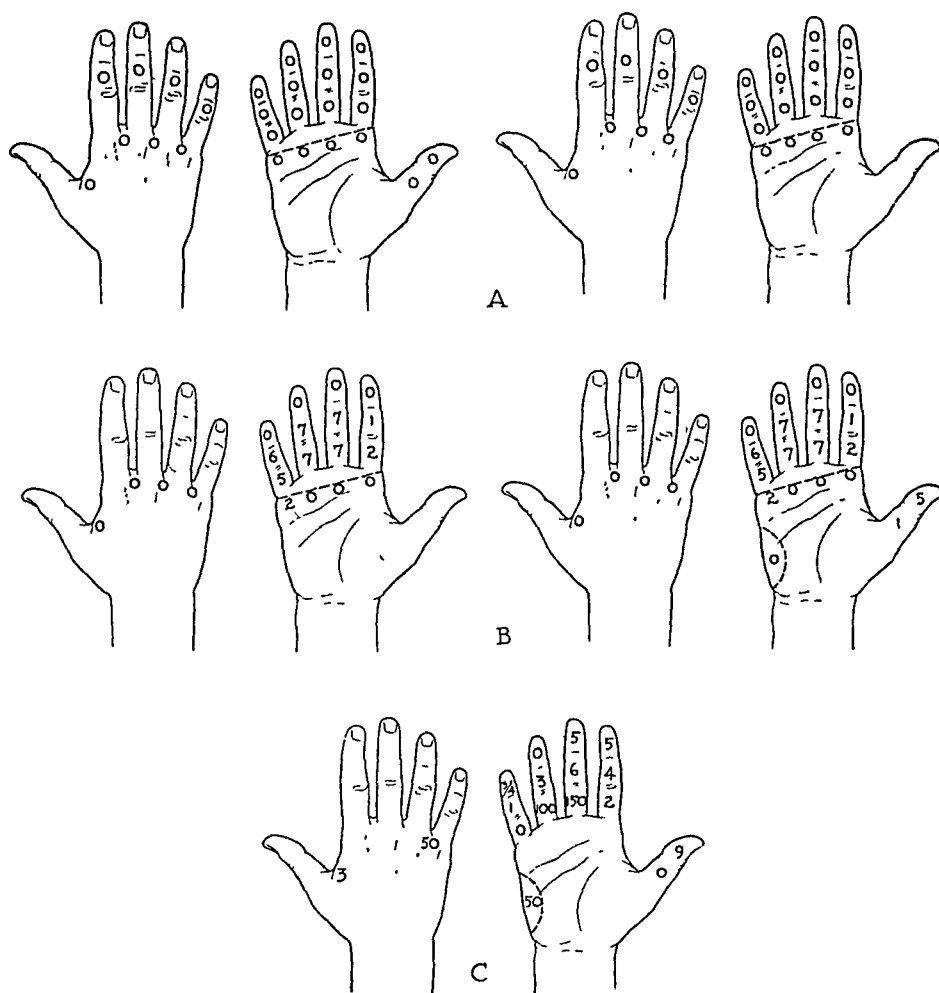


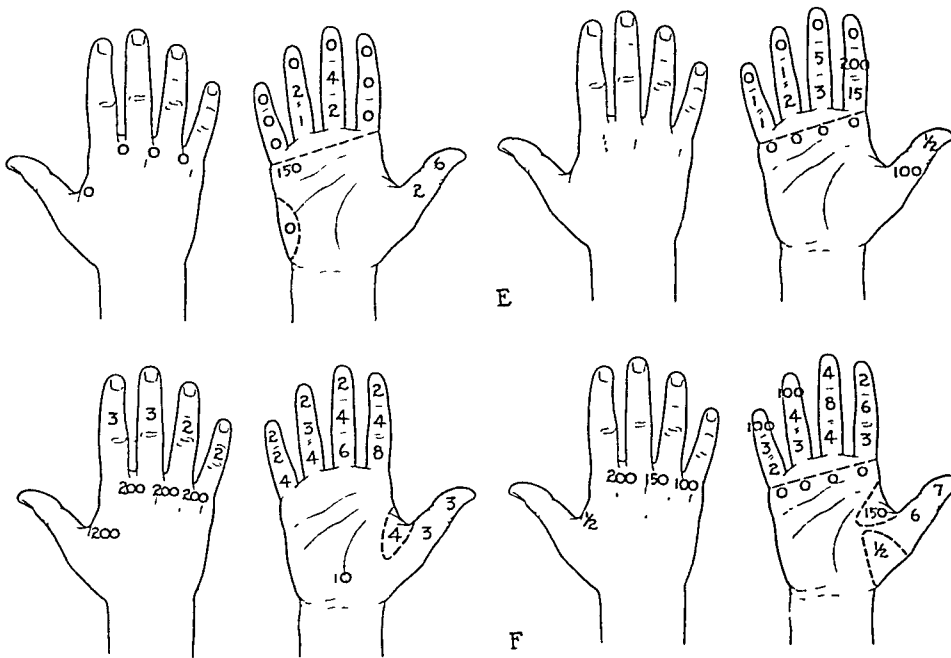
FIG. 212. Dynamometric studies of small hand muscles movements in median-ulnar nerve lesions.

A. Anatomical section; complete sensory loss.

B. Incomplete but severe lesion; complete sensory loss over ulnar, incomplete sensory loss over median area.

C. Incomplete but severe lesion; incomplete sensory loss over ulnar and median.

nerves produced complete paralysis of all of the phalanges of the fingers and thumb and severe lesions, not anatomic sec-



- D. Incomplete but severe lesion; complete sensory loss over ulnar and median.
- E. Complete ulnar, incomplete median; sensory loss over ulnar complete, over median, incomplete.
- F. Incomplete or recovering lesion; sensory loss over ulnar complete; no loss over median in three and only partial loss in two cases.

preted alone, are insufficient guides to whether or not one of
 these nerves is severed, and if severed, which one. Because of

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the widespread supplementary motility, recovery of function is difficult to study and a definite pattern of involvement cannot be determined (Fig. 212).

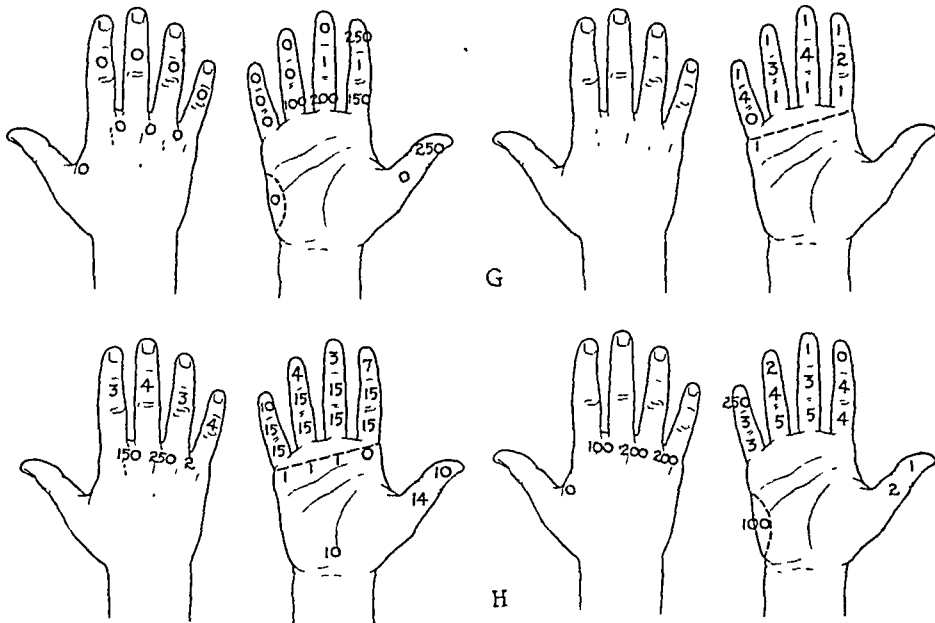


FIG. 212. Dynamometric studies of small hand muscles movements in median-ulnar nerve lesions.

G. Complete ulnar analgesia and incomplete sensory loss over median with regeneration of ulnar nerve.

H. Incomplete ulnar and median nerve lesions; no sensory loss in ulnar; slight sensory loss in median nerve area.

When observed some time after injury (more than five months) it would appear that anatomic section of both ulnar and median nerves produces complete paralysis of movement of all of the phalanges of the fingers and thumb. Severe lesions, not anatomic sections, showed some movement in some of the phalanges of all of the fingers.

As in isolated lesions of the median nerve, so when combined with an ulnar nerve lesion, it was seen that in partial or recovering lesions and in more than half of the severe lesions, not anatomic sections, incomplete sensory loss in the median distribution was present.

Only a few of the cases of incomplete ulnar and median nerve lesions showed incomplete sensory loss in the ulnar distribution, and in only one of seventeen cases was this the

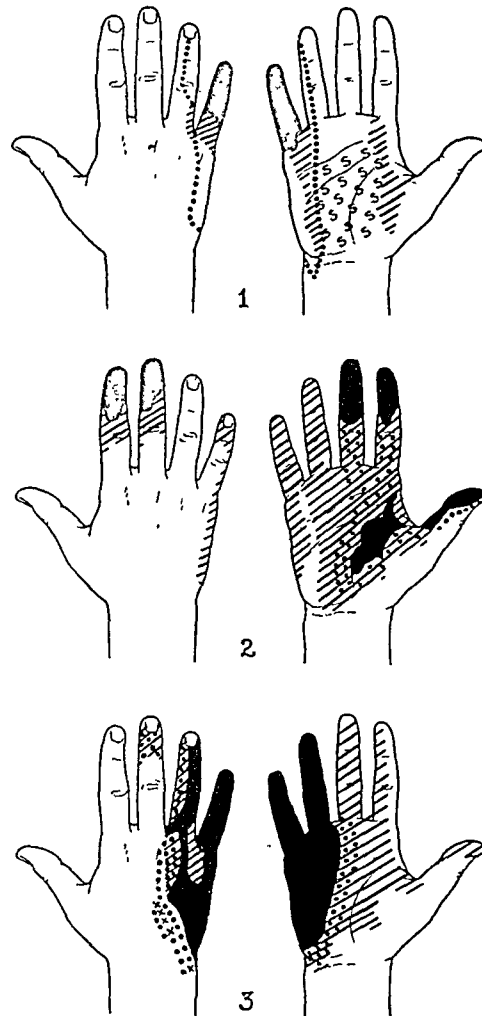


FIG. 213A.

A. Ulnar and median nerve lesions; postoperative recovery. 1. Return of sensation in area between injured nerves. 2. Neurolysis of ulnar, section of median with suture; return of pain but not cold sensation. 3. Neurolysis of median, section and suture of ulnar; patchy return of pain sense in ulnar distribution.

case when phenomena of motor regeneration were inconclusive. Only one severe incomplete lesion showed incomplete sensory

loss of the ulnar. In complete lesions of the ulnar and incomplete lesions of the median when sensory regeneration was demonstrable motor regeneration was likewise present.

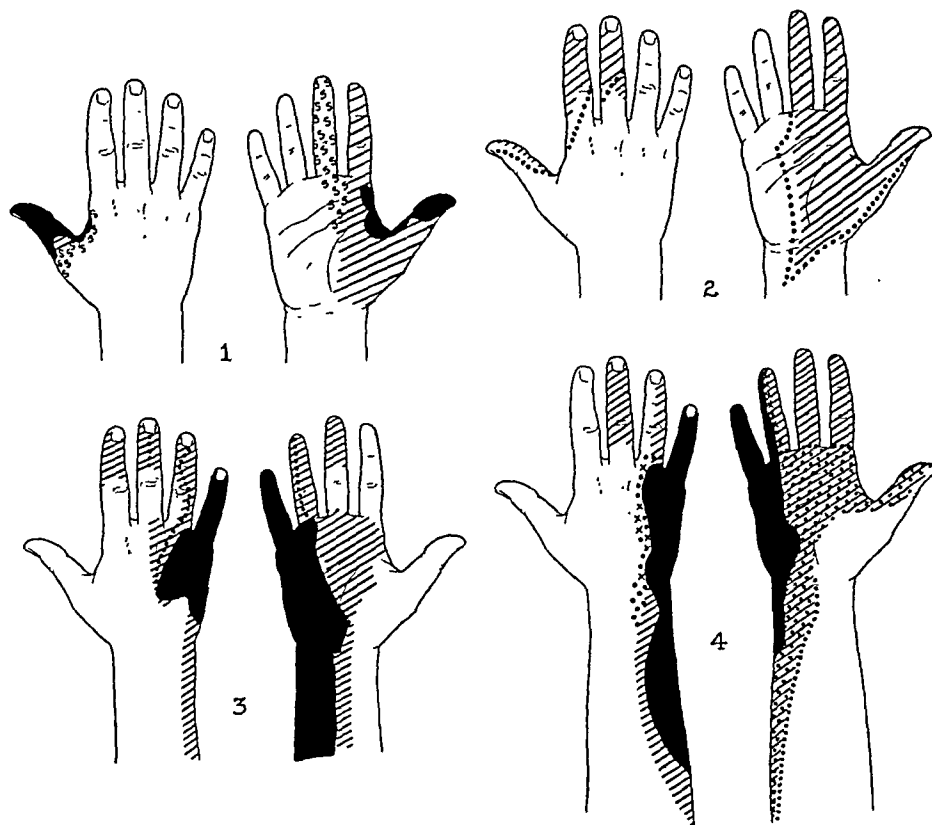


FIG. 213B.

B. Ulnar and median nerve lesions; spontaneously recovering. 1. Complete recovery of ulnar; recovery of pain in isolated area of median and diminished tactile loss. 2. Recovery of ulnar. Marked loss of cold but no loss of pain sense in area and median nerve. 3. Marked sensory loss in ulnar area; recovery of pain, touch and temperature sense in isolated supply of median. 4. Recovery of cold and temperature sense in isolated supply of median.

SIGNS OF MOTOR RECOVERY

The motor recovery follows the course of recovering isolated lesions of the median and ulnar nerves.

SIGNS OF SENSORY RECOVERY

Sensory recovery followed the same course, and a notable observation is the return of sensibility in the area between the

sensory supply of the ulnar and median nerves. This is never noted in complete lesions.

Interlacing, patchy return, return of sensibility in areas of isolated supply and dissociation and loss to cold and touch were also observed (Fig. 213).

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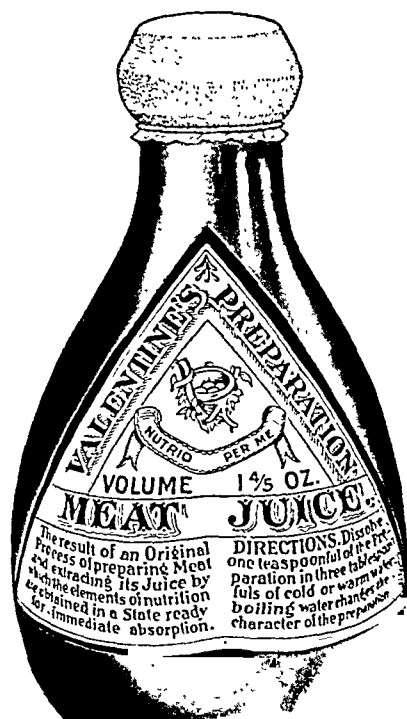
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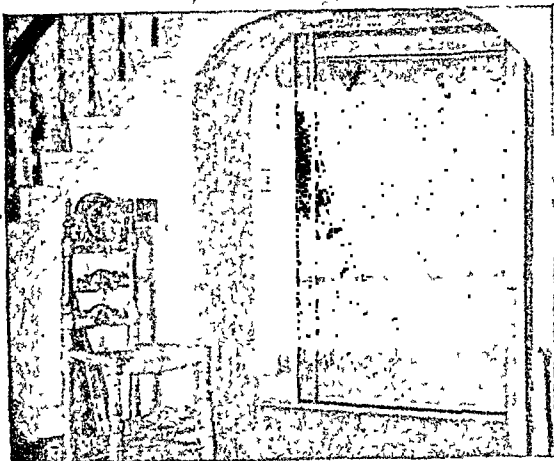
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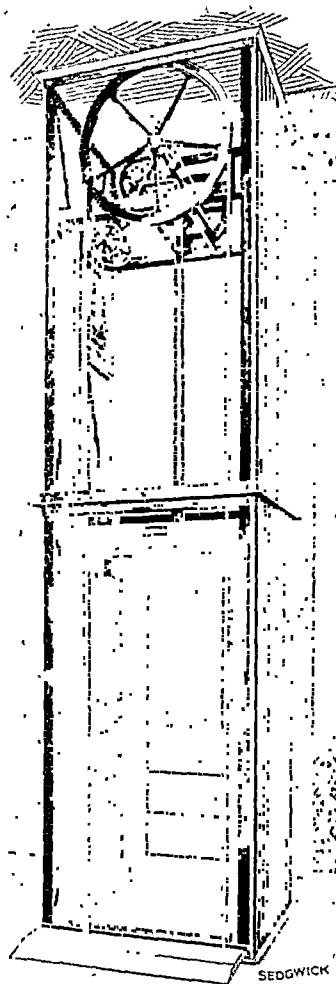
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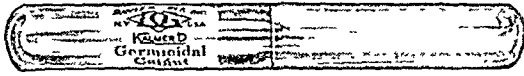


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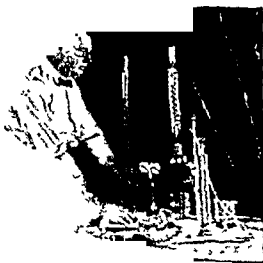


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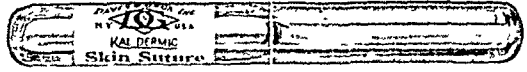
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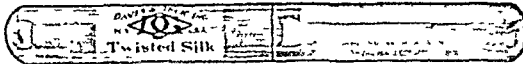


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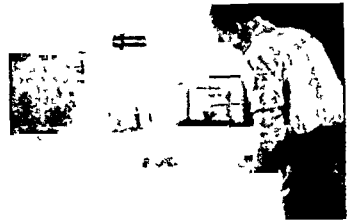
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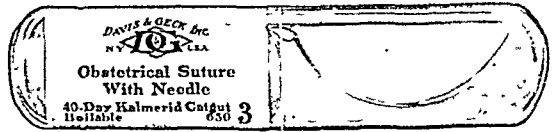
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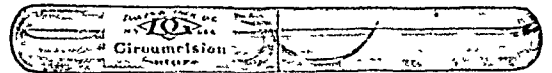
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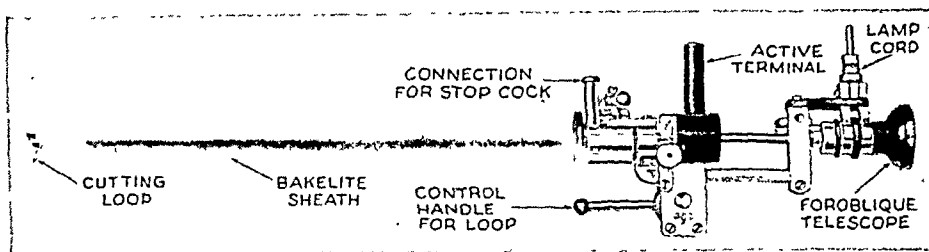
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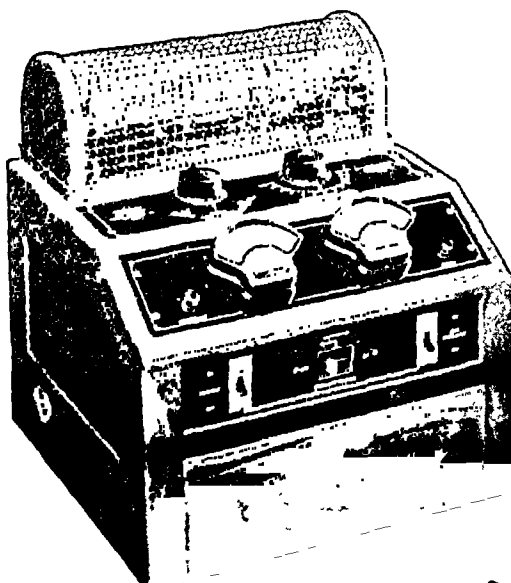
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GENERAL INFORMATION

Original articles are published only with the understanding that they are contributed exclusively to this Journal. Manuscripts offered for publication, correspondence relating to the editorial management and books for review should be sent to The Editor, THE AMERICAN JOURNAL OF SURGERY, 76 Fifth Avenue, New York, N. Y.

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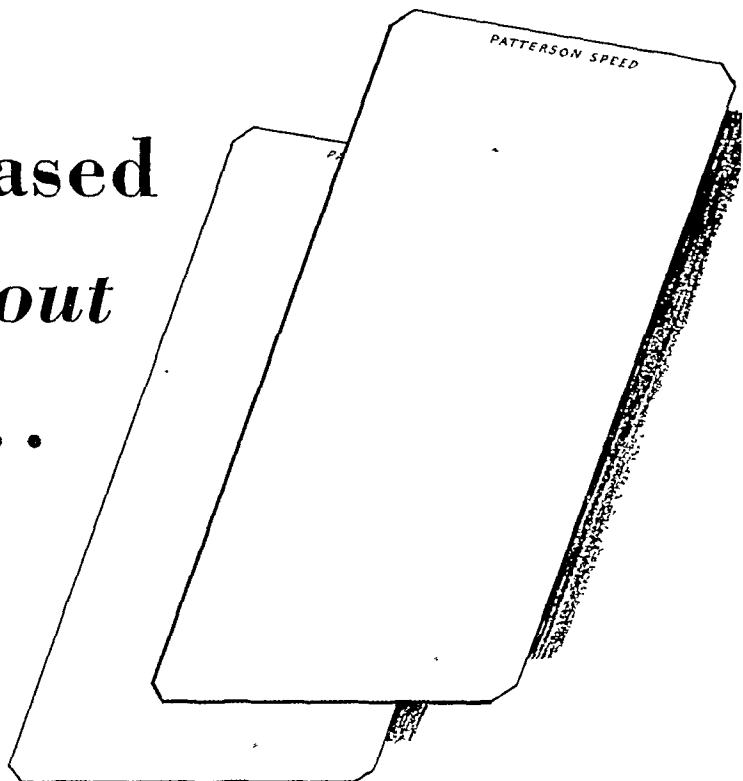
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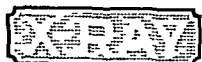
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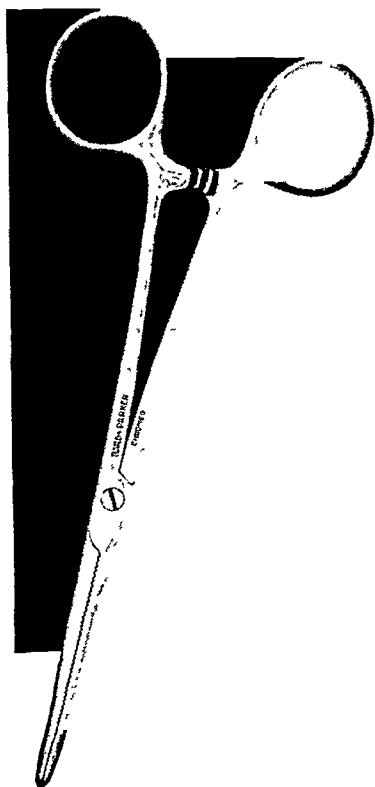
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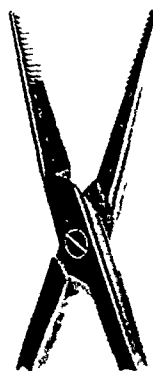
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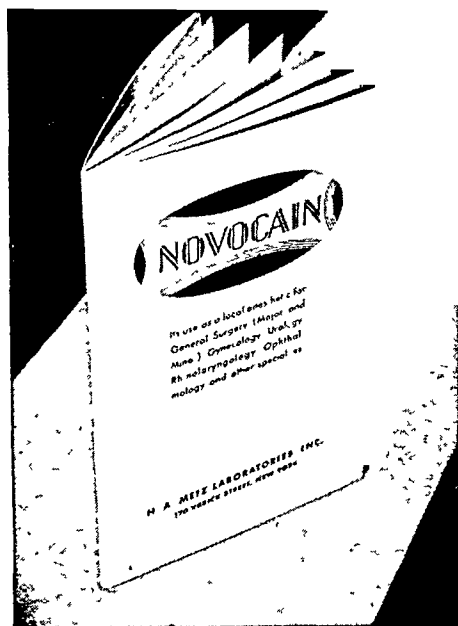
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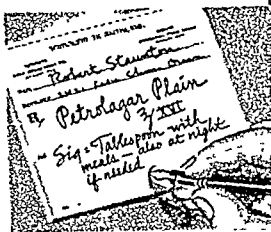
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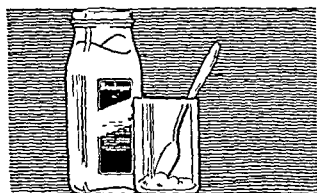
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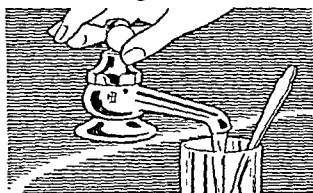
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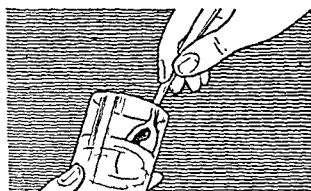
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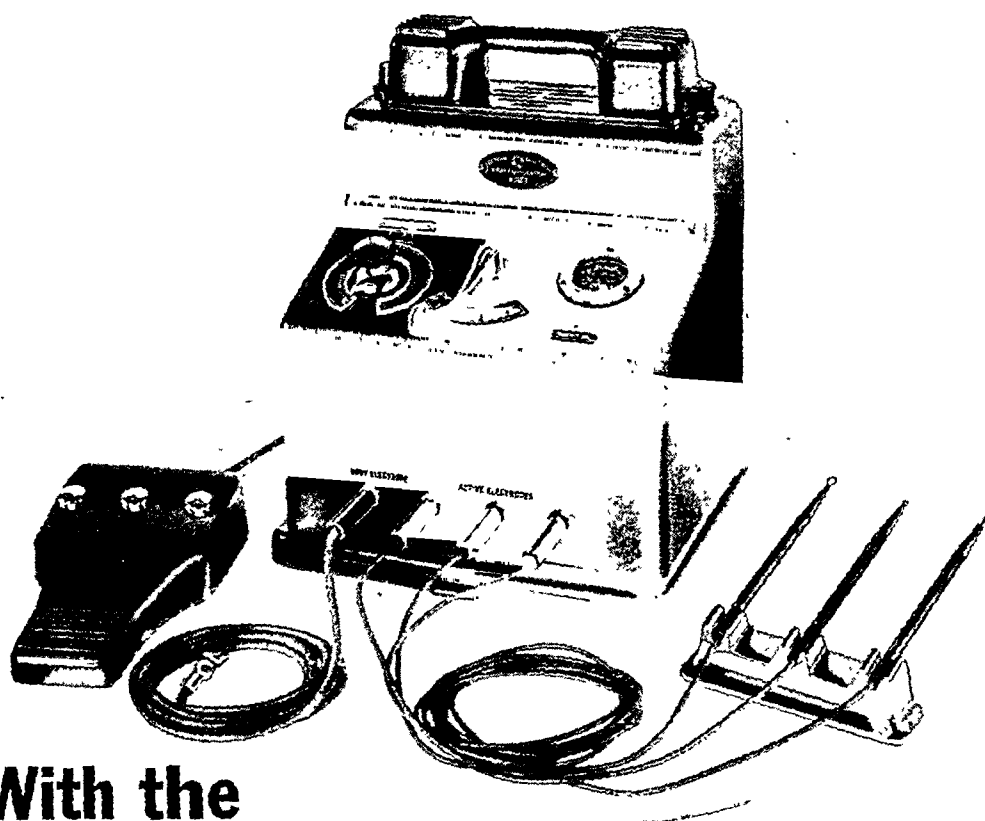
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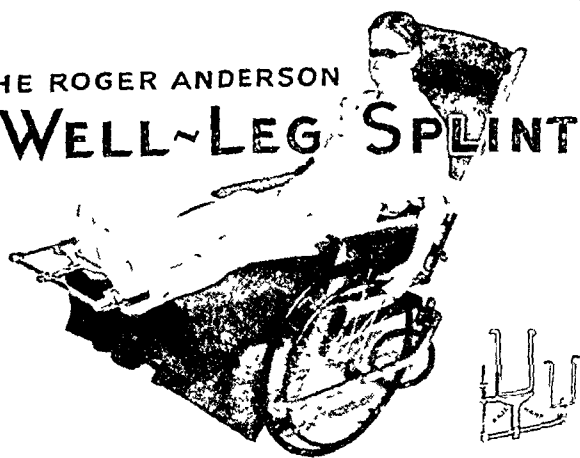
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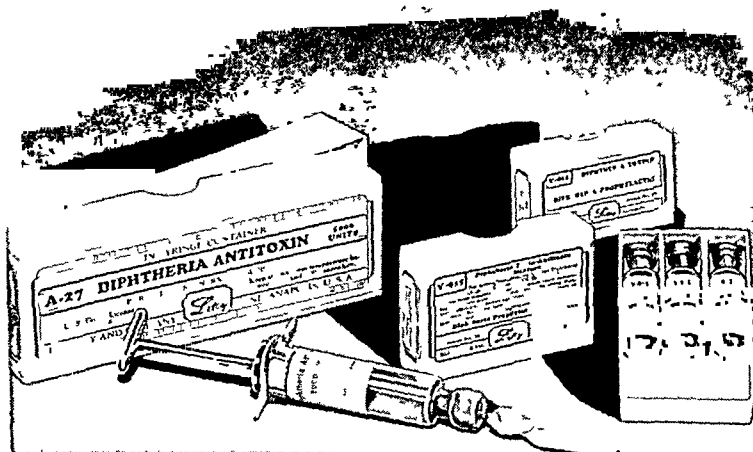
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NEW SERIES, VOL. XVII

SEPTEMBER, 1932

No. 3

VOLVULUS OF THE LARGE AND SMALL INTESTINE

WITH REPORT OF A CASE OF VOLVULUS OF CECUM, ASCENDING COLON & ILEUM*

JOHN W. KEEFE, M.D., L.L.D., F.A.C.S.

PROVIDENCE, R. I.

FORTUNATELY for mankind, volvulus of the intestine is of very rare occurrence. However when found prompt surgical treatment is imperative. Volvulus may be described as a twisting, or turning, or rotation of the bowel upon its mesenteric axis. This may result in circulatory disturbance, obstruction, peritonitis, and gangrene of the particular loop affected. Various authors attribute from 3 to 4 per cent of all intestinal obstruction to volvulus.

The small intestine with the exception of the duodenum, and the large intestine with the exception of the rectum, may become involved, although volvulus is most frequently found in the large bowel. The common sites are: the sigmoid colon, about 75 per cent of all cases are found here; the cecum; the cecum and ascending colon; the cecum, ascending colon and ileum; and the ileum alone.

Rotation of the volvulus may vary from half a circle, 180 degrees, to three complete turns. Rotation is generally clockwise. Nearly 80 per cent of all cases of volvulus are found in men, usually between the ages of forty and sixty years.

The causes of volvulus have not been very clearly determined. It is agreed that the presence of a long mesentery or mesocolon is a determining factor. But exactly what causes have produced a

long mesentery? Some authors attribute volvulus to constipation, others to congenital imperfections. Adhesions following an operation, approximation of the foot points of the omega loop which we call the sigmoid or pelvic colon, a long mesosigmoid with a narrow base, a pendulous freely movable cecum and ascending colon predispose to a volvulus. Rotation may be caused by straining at stool, injury, peristalsis induced by active purgation, and violent twisting movements. How do we account for volvulus of the cecum and ascending colon where the feces are liquid?

In the case of volvulus, the onset of abdominal pain is usually sudden and frequently occurs in a person in good health. This pain is severe and often colicky. The griping pain is due to violent peristaltic movements of the intestine caused by obstruction of the bowel. There is tenderness on pressure. Vomiting is found early when the twist is in the upper portion of the small intestine, and late when the sigmoid is involved. The abdomen is distended and may show violent peristaltic movements. The pulse, temperature and leucocyte count are usually increased, though they may not be affected for a considerable time.

It must of course be borne in mind that all these symptoms are seldom found at

* Read at the 44th Annual Meeting of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, White Sulphur Springs, W. Va., Sept. 14, 1931.

the same time. On the whole tenderness on pressure is one of the most constant and important indications of the disease, though it is also distinguished by the acute onset, tympanitic distention of the abdomen and colic without fever.

TREATMENT

Rectal enemata, given with the patient in the knee chest position, in the early stages may untwist a volvulus of the sigmoid.

In the treatment of volvulus morphia should be avoided scrupulously, as it renders the patient insensible to pain and tenderness and so hinders the surgeon in making an early and accurate diagnosis. The chief thing to be accomplished is prompt and efficient drainage of the affected loop and the intestine above the obstruction. A prolonged operation may prove fatal to the patient. Too much should not be attempted in the acute, critical stage of volvulus. The simplest operation should be performed to save the patient's life even though a second one may be foreseen.

Primary resection of the bowel with anastomosis should not be attempted unless the operator is exceptionally skillful so that the operation may be performed both quickly and accurately. A lateral anastomosis is preferable to an end-to-end union. A simple ileostomy or cecostomy may give the patient the best chance of recovery. Cecostomy may be desirable when the sigmoid is the seat of the volvulus. The Mikulicz two-stage operation, first bringing the gangrenous portion outside the abdomen, and suturing the sound ends to the wound, and then closing the fistulae at a second operation, may be the operation of choice.

To prevent recurrence of volvulus where resection is not done, Waterhouse suggests shortening the loop by suturing the mesentery in folds parallel to the axis of the intestine.

The mortality of volvulus, from 50 to 65 per cent, is appallingly high. This is due chiefly to faulty diagnosis and delayed

operation. It is essential that the operation be performed promptly and expertly.

In order that we may operate promptly I feel we should do more work in the homes of people living in the country, who otherwise would have to be carried to a hospital miles away.

We have become too dependent on hospitals and routine. The young man today feels it is impossible to work unless he is surrounded by the shining tiles and conveniences of the modern hospital. But we must remember that many small community hospitals are staffed by inexperienced surgeons. We should make more of an effort therefore to help the country people, many of whom cannot go to a city hospital. In many cases also delay is fatal.

The case I am going to report is one of volvulus of the cecum, 8 inches of the ascending colon, and 6 inches of the ileum, which occurred in a young woman aged twenty-one, seven months pregnant. I have thought that it might be of interest to know how things were done thirty years ago.

Dr. Lace of Pascoag, a town about twenty miles from Providence, asked me to see a patient, a young woman, ill two days, who required an operation for acute appendicitis. As these were pre-automobile days my assistant, a trained nurse, and myself with a large kit bag made the train. This bag contained sterile sheets, towels, gauze sponges, sutures of various kinds, and instruments to enable one to deal with any abdominal condition requiring operation.

Upon reaching the cottage, I found a woman, twenty-one years old, married one year, seven months pregnant, abdomen distended by the pregnancy and the results of acute peritonitis, pulse rapid, temperature 101°F., pain on pressure most marked in the right iliac region. She had previously been nauseated and had vomited.

We all thought that we had to deal with an acute appendicitis, so we made preparations to operate.

The dining table served as the operating table; the time-honored wash boiler as the

sterilizer. In the wash boiler three-quarters full of water were placed two large pitchers and basins, such as yet may be found in country hotels, and the instruments and sutures wrapped in a canvas roll. This roll was tied with a bandage, one end of which was left outside the boiler to enable one to lift out the hot package. One of the pitchers was filled with hot water, a sterile towel tied over the top, and set outside to cool. The other pitcher contained hot sterile water taken from the wash boiler. Two nickel trays were sterilized by igniting a small quantity of alcohol poured into them. Then the sterile instruments were placed in these trays in a hot 1:40 carbolic solution.

Dr. Lace administered ether. The abdomen was scrubbed with a 1:2000 bichloride of mercury solution. A right iliac, muscle splitting incision was made allowing entrance to the abdominal cavity. A black, largely distended mass of intestine presented and was withdrawn outside the abdominal cavity. This proved to be the cecum, the appendix, 6 inches of the terminal ileum, and 8 inches of the ascending colon. This loop of the intestine at the site of the mesentery was twisted to the right once and a half around, thus constricting the blood supply to the bowel. The loop of intestine was untwisted, but no color returned when the pressure on the vessels was relieved and an incision was made in the colon releasing dark liquid fetid contents. However the loop was left hanging outside the wound with the possibility of a return of the circulation. Sound portions of the ascending colon and ileum were placed parallel and stitched together with two rows of Pagenstecher thread, and these portions of bowel were sewed to muscle fascia and skin. Drains were placed in the lower part of the wound into Douglas' pouch and the right iliac fossa. The wound above the drains was united up to the exit of the two sound portions of the intestine which were sutured in the mid portion of the wound. An aseptic dressing was applied and the patient was left to the care of a real trained, motherly nurse, who not only did excellent nursing for the patient, but cooked for herself and the husband and kept the house in order, a rare combination in these days. Next day we saw the patient and no color having appeared in the loop of intestine we removed it flush with the skin and irrigated the bowel with normal salt solution through two openings, one in the colon and one

in the ileum, presenting like the openings of a double-barrelled gun. The general condition of the patient was good. The fourth day Dr. Lace telephoned me that the patient had a miscarriage, the infant dying in a few hours. I saw the patient from time to time over a period of three weeks, the sutures removable had been removed, the patient was sitting up and in excellent and cheerful spirits. The closing of the fecal fistula I deemed it wise to defer for several months.

As the patient had regained her normal health and composure and had become accustomed in a measure to the presence of the fecal fistula, I had her admitted to St. Joseph's Hospital at Providence. There was some slight discharge of feces from the rectum, although most of the feces came through the opening in the end of the ileum.

Ether was administered. With one blade of a scissors in each of the bowel openings I cut the bowel walls to a depth of 2 inches between the double row of stitches I had placed to unite the walls of bowel at the time of the former operation. The mucous membrane of the bowel was dissected free, inverted and united with a continuous plain gut suture, reenforced by Cushing right-angle sutures. The bowel muscular layers were dissected free and united with catgut sutures. The muscular wall of the abdomen was then sewed over the bowel with chromic gut sutures. The margin of the skin wound near the fistulae were excised and the skin united with a continuous subdermal silkworm gut suture. A fibroid growth, the size of a pigeon's egg, was removed from the upper left quadrant of the right breast. Next day the bowels moved with the aid of calomel, magnesium sulphate and enema. Three days later the bowels moved regularly with citrate of magnesia and enemas. The eighth day the subcutaneous suture and the suture in the breast wound were removed. Primary union occurred in both.

The subsequent history follows. About a year after the second operation she was delivered of twins at full term. They both lived but a few months.

Six years later she was living in a city forty miles away, but came to see me. She said she was pregnant about eight months and had consulted a physician who told her it would be necessary to have a Cæsarian section on account of her former operations. I gave her the names of three physicians in her city who

were competent and honest. Two weeks later the patient consulted me again and asked me to care for her. She was in such evident distress that I consented and she was admitted to the Providence Lying In Hospital. One day labor pains began about 10 A.M. and in two hours a robust boy was born who is living today and is a great joy to his mother. The delivery and convalescence were normal.

In conclusion I should like to point out:

1. That prompt surgical intervention in patients with volvulus is imperative.
2. That the simplest operation is best.
3. That emergency operations in the country should not become obsolete.

The surgeon should have the courage of his convictions. Time, patience and

courage on his part are necessary, but many lives may thereby be saved.

My object in presenting this subject will have been attained, if I have succeeded in impressing upon you the importance of early diagnosis and prompt operative interference.

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INGUINAL AND FEMORAL HERNIA*

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THIS study is based on an experience with 806 herniorrhaphies performed by the writer on 778 patients, the results of which are reported in considerable detail in the hope of bringing out certain facts bearing on the subject of inguinal and femoral hernia and, especially, on the question of the prevention of recurrence following operation. In our follow-up investigations 619 patients answered questionnaires; most of these patients were personally re-examined, furnishing an accurate end-result check of 80 per cent of the cases.

INGUINAL HERNIA

Of the 778 patients 558 had unilateral inguinal hernia, 77 of the patients being females and 481 males, or a relative incidence of 14 per cent to 86 per cent. The oldest patient was eighty-eight and the youngest three months, the average age being fifty-five. The majority were engaged in strenuous labor, being miners, railroaders, farmers, carpenters, mill hands, etc. Most patients mentioned nothing in particular regarding a contributing cause; although about one-fourth referred to lifting as the probable exciting factor, next in order being a fall. The average duration of the hernia was five years, 5.9 per cent being of the direct variety, 3.9 per cent being strangulated on admission. Seven patients had been operated upon elsewhere on the opposite side; while the total number of patients who had been operated upon elsewhere for hernia and on whom we operated to repair hernias on the opposite side, or to repair recurrent hernias, was 35 or 6.3 per cent.

Symptoms: At least 70 per cent of the patients complained chiefly of a "painful lump." Of the 558 patients with inguinal hernia 14 had been incapacitated "many

times"; while 22 had suffered from intermittent strangulation. One hundred and fifty, or 26.9 per cent, had worn trusses, but, in most cases, the patients had found the truss unsatisfactory. Only 50 per cent of the hernias were complete, i.e., the hernial mass extending well beyond the external ring or into the scrotum.

At operation the contents of the sac were found to be as follows:

Ileum	27 cases
Ileum and cecum .	1
Ileum and sigmoid..	1
Ileum and appendix	3
Appendix..	2
Appendix and cecum	1
Appendix, cecum and ascending colon .	1
Sigmoid.	8
Sigmoid and descending colon	1
Portion of bowel involved not mentioned.	2
Omentum.	217
Fat (preperitoneal).	13
Fluid..	2
Number of hernial sacs containing abdominal structures..	279 or 50 per cent

Appendectomies were performed on about 1 per cent of the patients; while in 13 per cent masses of omentum were resected. In 22 cases, or 3.9 per cent, an undescended testicle was found; in the majority of cases it was possible to perform an operation resulting in establishment of the testicle in its normal position in the scrotum. In 6 patients the testicle, being rudimentary, was removed. In one case a tube and ovary were found within the sac, both of which were excised.

BILATERAL INGUINAL HERNIA

Of the patients with inguinal hernia there were 160, or 22 per cent, with bilateral involvement, 155 being males and 5 females. In this group over 50 per cent were

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patients who were engaged in hard physical labor, being iron workers, carpenters, railroaders, puddlers, laborers, etc. Forty patients, or 25 per cent, were wearing trusses at the time of examination, a few having obtained some relief for a short time, but all, sooner or later, complaining of great dissatisfaction with these devices. Of the 160 patients 128 had bilateral indirect inguinal hernias, 17 had bilateral direct inguinal hernias, and 15 cases were mixed. There were 2 of bilateral direct inguinal hernias which were sliding on both sides; 2 of the indirect variety were sliding on both sides and 2 bilateral indirect sliding on one side only. Of the 160 cases of bilateral inguinal hernia 8, or 5 per cent, were sliding hernias, a greater incidence of sliding hernia being found in patients with bilateral hernia. In this group of 160 cases, 5 had been operated on elsewhere and had come to us because of a recurrence.

The sac contents in order of occurrence were: omentum, fat, bladder, cecum, cecum and appendix, appendix, ileum, colon, and, occasionally, the sigmoid, although, of course, the latter is the chief finding in sliding hernia.

COMPLICATIONS

Complications following operations on these patients occurred in about 10 per cent of the cases, the largest number being in the pulmonary group, consisting of a cough with other evidences of bronchitis. Urinary retention was present as a rather frequent complication, occurring in 54 of the cases, or 9.6 per cent. Epididymitis occurred rarely, but was occasionally seen. Small hematoceles occurred in 7 cases, or 1.2 per cent, pointing to the importance of careful hemostasis in operations performed for the relief of hernia.

FEMORAL HERNIA

In the entire group of 778 patients there were 60 with femoral hernia, a proportion of 7.7 per cent femoral to 92.3 per cent

inguinal, 65 per cent being females and 35 per cent males. The average age was fifty-one years. The majority of the patients were housewives. Only a few could tell exactly when the hernia occurred, or how it occurred; although a few spoke of a mass suddenly appearing following heavy lifting. Several mentioned childbirth as the possible cause. The average duration of time between the onset and the patient's appearance for treatment was sixteen years. Many of these patients, a far larger proportion than was the case with the inguinal hernia group, experienced incarceration and even strangulation, or obstruction, one or more times, femoral hernia being inclined to these secondary complications far more frequently than is the case with inguinal hernia. In the group of 60 patients with femoral hernia 13 had been troubled with strangulation one or more times; while 20, or 33 per cent, were suffering from strangulation on admission to the hospital. Some had worn trusses with satisfactory results. Of the 60 cases 2 were bilateral, the majority, however, being single and occurring more often on the right side. Ten per cent of the patients coming to us with femoral hernia had previously been operated on for actual or alleged hernia in the *inguinal* region, in certain of these cases the symptoms at that time probably being due to an unrecognized femoral hernia. In most of the cases the sac contained only omentum; although, occasionally, a loop of ileum was found. Resections were not necessary in any of the cases of strangulated femoral hernia, this being also true with the strangulated inguinal group, it being our conviction that resection is rarely necessary in the strangulated cases. We did not deem it advisable in any of our cases to resect, finding that in nearly all cases of strangulated bowel, although the color of the intestine may be quite dark, the gut is still viable; hence, only in the rarest instances, will gangrene ensue. There were no recurrences found in the follow-up study of the patients in the femoral group.

RECURRENCES

There were no recurrences in the femoral group. In the inguinal group 19 patients, or 3.4 per cent, reported recurrences but, on re-examination in a large number it was found that no actual recurrence was present; although some patients had even again resorted to trusses. In about one half of the patients reporting persisting trouble a definite recurrence, however, was found, with a final figure of 1.6 per cent for recurrence.

The longest interval of time between operation and recurrence was four and one-half years and the shortest two weeks, the average being thirteen months. Seventy-three per cent occurred within six months. The number of patients who will complain of symptoms of a suspected recurrence and who, after a re-examination, are found to have none is quite surprising; consequently, this tendency on the part of some patients must be borne in mind in any follow-up study of a group of such cases, and the patient's statements evaluated only in the light of it. No definite conclusions should be drawn as to the incidence of recurrence without a check-up examination. In the group of patients who complained of what they thought was a recurrence and who came to the hospital for re-examination, was one who had even gone to another institution to be operated upon, only to have no hernia revealed.

A certain number of patients having inguinal hernias will develop small varicoceles or hydroceles following operation. In our group there were 6 of these, the condition often being considered by the patient as a recurrence of the hernia. Recurrences which were found actually to exist occurred in a group of patients operated on some years ago, chiefly by a technique in which chromic catgut was exclusively used. In later years we have used interrupted sutures of black silk in the internal oblique in closing the inguinal canal by a modified Bassini technique, during which time the percentage of

recurrence has been reduced, now being less than 1 per cent.

TREATMENT

The Bassini operation, or the modification of it as described by Watson,¹ is the procedure utilized more than all others, and, in the opinion of the authors, is the best operation we have for the treatment of inguinal hernia. Sooner or later in his career every young surgeon experiences an urge to write a paper on the technique of herniorrhaphy in which he presents some wrinkle as an original device or as an alleged improvement; yet most of them prove old and discarded schemes in a new guise. It must be borne in mind that the success of the operation depends entirely on the ability of muscle and fascia to adhere, a point about which some doubt has been felt, a typical paper on the subject being that of Seelig and Chouke,² whose animal experiments were conducted with a view to settling the question, their conclusion being that normal muscle will not permanently unite with fascia or ligament. Of greater significance, however, is the investigation of Koontz,³ the results of whose researches refute the findings of Seelig and whose conclusions, after a series of experiments on dogs with careful histologic studies, are that muscle unites firmly with fascia by the union of the latter with the fibrous components of the muscle and that the internal oblique and Poupart's ligament organize solidly, when these structures are brought into apposition and held there for a sufficient length of time.

It is about these points that the whole question of failure revolves. Surgeons report their percentage of recurrences variously, and the compilation of statistics varies widely due to faulty follow-up methods and to varied statistical procedures as much as to lack of surgical skill. The percentage is often so disconcertingly high that surgeons who have never before made a careful follow-up investigation of their own hernia cases may often experience

considerable surprise and disappointment following the completion of such a study.

The frequency of recurrences has led to innumerable modifications of the original Halsted (1889) and Bassini (1890) operations, the experimenters, however, often missing the point that the trouble is not as often due to the operation *per se* as to faulty technique in the attempt to carry it out. Coley⁴ has stated that in recurrent hernia he invariably finds the internal oblique firmly united to Poupart's ligament but, on the other hand, it is claimed by Seelig and Chouke that in operating for recurrent hernia Poupart's ligament is found smooth and glistening and entirely free from muscle attachments. This has been our own finding, our conclusions being that the recurrence is due to failure to establish a *firm* union between the internal oblique and Poupart's ligament with obliteration of the inguinal canal, a condition, however, resulting from faulty technique; but we disagree with Seelig that the recurrence is due to the inability of these structures to adhere. Two steps of the technique, the proper observation of which will contribute more towards assuring success than anything else in the procedure are: first, to see that all of the areolar tissue is carefully removed from Poupart's ligament and, secondly, to use suture material which will remain in place for a sufficient length of time to assure firm union between the muscle and the ligament; for this purpose we believe there is no better material than silk. If properly used and with perfect asepsis, this suture will accomplish what we expect of it and will never produce the complications, wound sinuses, etc., claimed by certain authors who seem unalterably opposed to the use of non-absorbable suture material.

MORTALITY

In the entire group of 806 operations there were 4 deaths, a mortality of 0.49 per cent. In the non-strangulated group the mortality was 0.1 per cent. In the group of cases of inguinal hernia there

were 2 postoperative deaths, a mortality of 0.36 per cent, one patient being a child two years old with a strangulated hernia, who died within forty-eight hours, apparently from cardiac failure; the other a male with a scrotal hernia, the patient's death occurring on the eleventh day from cardiac failure.

There were 2 deaths in the femoral group, or 3.3 per cent: the first patient, a male, aged fifty-nine, with a strangulated femoral hernia, who died from cardio-respiratory failure on the fourth day; the second, a male aged eighty-two, who was admitted with a large femoral hernia which had been strangulated for three days. The patient developed a fecal fistula on the seventeenth day, dying of peritonitis on the twentieth. In this case a resection might have been considered, but at the time of the operation the patient's condition was too grave to permit it.

"ACCIDENTAL" HERNIA

Accidental, or so-called compensable or "acute" hernia, about which so much has been written and which, as a subject, has assumed especial importance since the establishment of state compensation laws, has been well handled in the report of Coley, Wainwright, *et al*⁵ appearing in 1929. Probably, the following rules adopted by the Nevada State Commission cover the question as well as it can be covered and will be approved by most surgeons familiar with the subject.

Rule 1. Real traumatic hernia is an injury to the abdominal wall of sufficient severity to puncture or tear asunder said wall and permit the exposure or protrusion of the abdominal viscera or some part thereof. Such injury will be compensated as a temporary total disability and as partial permanent disability, depending upon the injured individual's earning capacity.

Rule 2. All other hernias, whenever occurring or discovered and whatsoever the cause, are considered to be diseases, causing incapacitating conditions of permanent partial disability, and are considered to have either existed from birth, to have been years in

formation, or both, and are not compensatory except under Rule 3.

Rule 3. All cases coming under Rule 2 in which it can be conclusively proved, first, that the immediate cause which calls attention to the presence of the hernia was sudden effort or severe strain or blow, received while in the course of employment; second, that the descent of the hernia occurred immediately following the cause; third, that the cause was accompanied or immediately followed by severe pain in the hernial region; fourth, that the above-mentioned were of such severity that they were noticed by the claimant and communicated immediately to one or more persons, are considered to be aggravations of a previous ailment or disease, and will be compensated as such for time or loss only, depending on the nature of the proof submitted and the results of the examinations.

COMMENT

There are several interesting points brought out in this study. The type of anesthetic utilized seems to have no bearing on the incidence of recurrence, in fact, but little on the progress of the case in general. In this series we used ether, nitrous oxide, spinal, local, ethylene, etc., giving each type of anesthetic a thorough trial. I am finally convinced that the ideal anesthesia for this type of work is spinal; although there are many who, for various reasons, are opposed to its use in the treatment of hernia. I feel, however, that such persons singularly fail to present valid arguments against its use. Were I to be operated on for this condition I would certainly choose spinal anesthesia, and it has been the choice of many of our professional friends on whom hernia operations have been performed in our hospital. We feel that spinal anesthesia is far better than nitrous oxide and infinitely better than local anesthesia; although we are aware this statement will not be accepted by those who are enthusiastic over local. To such persons we would suggest that they try spinal on fifteen or twenty hernia cases before they are too loud in its condemnation. Under this anesthetic the patient is infinitely more comfortable, and

the operation is greatly simplified. A small amount of anesthetic is required, rarely over 50 to 75 mg. of novocaine injected into the first lumbar interspace.

We are impressed with the importance of performing a bilateral herniorrhaphy in cases where there is a definite hernia on one side with a relaxed ring on the other. Such patients, if but one side is operated upon, frequently return in two or three years with a definite hernia on the side presenting the relaxed ring at the first examination.

We believe that there is no better procedure than a slightly modified Bassini operation. Whatever the technique, care should always be taken that constriction of the cord at the internal ring does not occur, that the vascular supply to the testicle is well preserved, and that any bleeding from the cord itself is thoroughly controlled before the incision is closed. If these details are not borne in mind, testicular atrophy, or hydrocele, or both, are very likely to ensue. Erdman⁶ reports hydrocele of the tunica vaginalis following operation for inguinal hernia in about 4 per cent of the cases in the New York Hospital.

I am impressed with the importance of carefully preserving the nerves, so placing them during the completion of the operation that they will not be impinged upon by sutures or by scar tissue. If this is not borne in mind, a large number of patients will, ultimately, complain of chronic pain.

Trusses should be condemned in the treatment of all but the thoroughly inoperable cases. I have found many patients wearing trusses who had no hernia whatever and who probably never did have; yet I rarely find a patient who has worn a truss with any degree of satisfaction. It is obvious that the truss should not be worn following treatment, and when it is prescribed, the surgeon must have slight confidence in the integrity of his operation.

There are certain individuals who, for reasons difficult to explain, seem especially hard to cure. One of our patients had had

three operations elsewhere before coming to our own institution; all of the operations were on one side, followed by a recurrence. The technique which had been successful in 99 per cent of the cases was carried out; yet this patient was not cured until he had been operated on four times, heavy, non-absorbable sutures finally being used. In some clinics fascial transplant sutures of the Gallie type would, in such a case, probably be resorted to. We have not cared for this technique as a routine procedure; neither do we like kangaroo tendon, our feeling being that if the patient cannot be promptly cured by a modified Bassini technique using silk sutures, he would be no better off if operated upon by a method calling for the use of these heavier materials. We are definitely in favor of silk, not being able to agree with those who state that it invariably causes trouble. We have had as few wound complications since using silk as we experienced in the days when catgut was exclusively utilized. We have not had to remove silk sutures, nor have we had a draining sinus due to silk in over 500 consecutive operations in which this material was depended upon. In this connection it is repeated that the cure of inguinal hernia depends on the complete and permanent closure of the inguinal canal, and that this condition can be achieved by the accurate and permanent apposition of the internal oblique muscle to Poupart's ligament. If these are to

adhere, they must rest in intimate contact for a long time, and, therefore, non-absorbable sutures are of distinct advantage. Although Scudder⁷ is opposed to the use of non-absorbable sutures, Grant⁸ states that by the application of two or three non-absorbable sutures in closing the posterior wall of the canal by the Bassini technique there will be fewer recurrences, an opinion in which we completely concur.

CONCLUSIONS

1. Recurrences following adequately performed operations for inguinal hernia should not exceed $1\frac{1}{2}$ –2 per cent.
2. In a follow-up study of inguinal hernia many patients will report a recurrence which, on physical examination, is found not to exist.
3. Recurrences following operation for femoral hernia should rarely, if ever, occur.
4. Resection of the bowel is hardly ever necessary in strangulation, yet is indicated, of course, if gangrene is developing.
5. The modified Bassini technique is the best operation for the treatment of inguinal hernia and silk the best suture material for approximating the internal oblique muscle and Poupart's ligament.
6. Spinal is the nearest to the ideal anesthesia yet advanced in the treatment of inguinal hernia, this being especially true in the strangulated forms.
7. Mortality in non-strangulated hernia should not exceed 0.1 per cent.

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LYMPHOSARCOMA OF THE JEJUNUM*

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LYMPHOSARCOMA or lymphoblastoma of the jejunum is quite a rare condition; more common is carcinoma

occur at any age, but mostly between the ages of thirty and forty years. Most of the cases reported have been in females. In

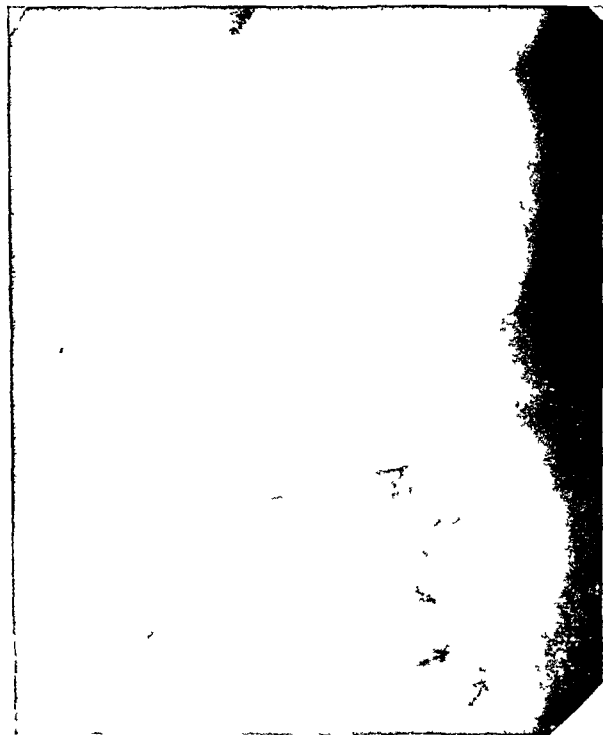


FIG 1.



FIG 2

of the jejunum.¹ The order of occurrence in the gastrointestinal tract is the ilium, cecum, jejunum, appendix, transverse colon, sigmoid colon, duodenum, and descending colon.²

Whether or not syphilis bears any relation to lymphosarcoma, Fischer³ states as follows: "As to whether syphilis bears an etiological relationship to the development of sarcomata, there are all sorts of opinions, from Schmidt, who remarks of sarcoma, that the luetic antecedents are not common, to von Eschsch, who states that in his clinic more than one-half of his sarcoma cases have been luetics." Fischer also states that sarcoma of the intestine may

Segal's collection of sarcoma of the intestinal tract, 34 cases in all, 19 were round-celled and 5 spindle-celled. The other tumors were alveolar or melanotic cystosarcoma, lymphosarcoma, myxosarcoma and endothelioma. Tuberculosis and sarcoma may coexist. Usually sarcoma begins in the submucosa.

Sarcoma of the intestine may reach considerable size. In counter-distinction to carcinoma, it involves a considerable portion of the bowel, and is much more likely to grow into the neighboring organs, especially the mesentery and omentum. It may also set up metastases in the liver, kidney, spleen, and retroperitoneal glands. Segal asserts that symptoms of stenosis

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occur in half the cases. Usually the neoplasm involves only the tela muscularis and mucosae, the serosa being seldom



FIG. 3.

involved. The tumor may compress the vena cava, bile passages, pancreatic duct and ureter. Ulcerations are very frequent and may lead to perforations. Mirotworzew⁴ states that in cases of sarcoma of the intestine, adhesions with neighboring organs are much rarer than in carcinoma.

The typical growth of lymphosarcoma is composed of delicate reticulum in meshes of which lie cells of lymphoid character. It fails to respect the capsules of the lymph glands, but grows rapidly, involving and infiltrating adjacent tissues.⁵ The intestine becomes very rigid and edematous, and the folds of mucosa are all greatly swollen.

Mirotworzew describes a typical lymphosarcoma as beginning in the submucous lymphatic glands and spreading along the intestine. If the tumor reaches the mucosa, it is under the influence of constant irritation, and thus ulcerates the walls of the intestine.⁴

The symptoms vary greatly. In most of the cases⁶ the following symptoms are the most common:

1. Loss of weight.
2. Loss of appetite with or without symptoms of obstruction; therefore there may or may not be vomiting.
3. Compression of organs and vessels.
4. Pain in the epigastrium.
5. Scanty urination.
6. If obstruction is quite acute, usual symptoms of high obstruction appear and the patient becomes quite sick.
7. Local movable mass with or without tenderness.
8. Slight rise in temperature.
9. Free acid may be lower than normal or even absent.
10. Amount of gastric retention proportional to obstruction present.

It is very difficult to make an absolutely correct diagnosis, and usually this is done only at time of operation.⁴ The disease must first of all be differentiated from carcinoma. The following points are highly valuable for consideration in such a differentiation. First, in cases where the x-ray shows constriction, carcinoma must be considered because in lymphosarcoma there may be constriction or dilatation with or without obstruction. It is interesting to note that in most of the cases x-ray studies were valueless, but in our case the x-ray pictures were very valuable. Second, pain seems to be more constant in lymphosarcoma than in carcinoma, and the mass in lymphosarcoma seems to be less fixed than in carcinoma. The disease must be differentiated from Hodgkin's disease and lymphocytic aleucemia, both of which resemble lymphosarcoma.

The treatment is, of necessity, resection and radiation, or in those cases that are inoperable, radiation alone. Bloodgood⁷ makes the following very interesting statement: "The one lesion of which, as far as I know, surgery has never accomplished a cure is lymphosarcoma of the lymph glands, and apparently radium has done so. Therefore as soon as this diagnosis is established, radiation should be given and continued at intervals through the entire lymphatic gland system."

Prognosis is not very favorable. According to Fischer,³ the postoperative mortality of these cases is very high. Death is

3. Mass felt in lower left quadrant. Palpable near midline.

4. Abdomen almost a doughy consistency.

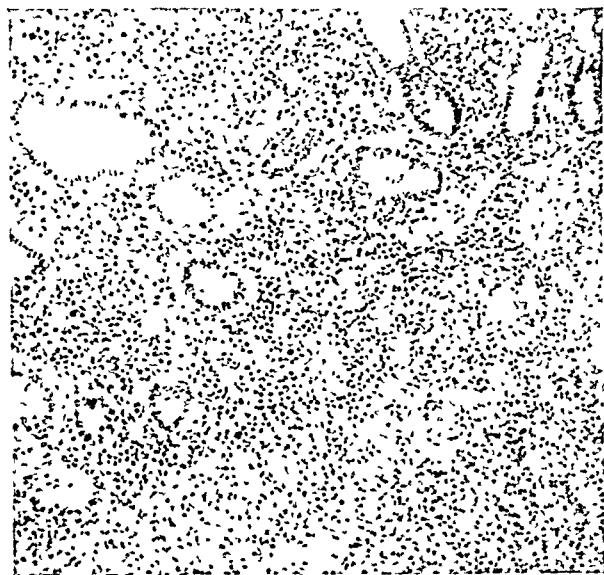


FIG. 4. Tumor cells in the mucosa (low magnification).

usually due to peritonitis, and for that reason he advises drainage in all the cases. Death may result from rapid recurrence or the patient may be well from one to five years.

CASE REPORT

Mrs. N. M., forty-six years of age, entered the medical service of Dr. W. E. Cary at the Chicago Memorial Hospital February 13, 1931, giving the following history and symptoms:

1. For the past two years occasional attacks of pain in epigastrium.

2. Vomiting of green bile.

3. Loss of appetite and weight.

4. Colicky, continuous pain in epigastrium, belching, and nausea.

5. Four weeks before admittance she vomited constantly, and was unable to retain very much on stomach.

6. Obstinate constipation.

7. Past illness negative except for cholecystectomy and appendectomy eight years previous.

Examination upon admission revealed the following findings:

1. Chest and heart negative.

2. Abdomen, large, soft. Tenderness elicited almost anywhere on deep pressure. Most marked in upper right and lower left quadrants.

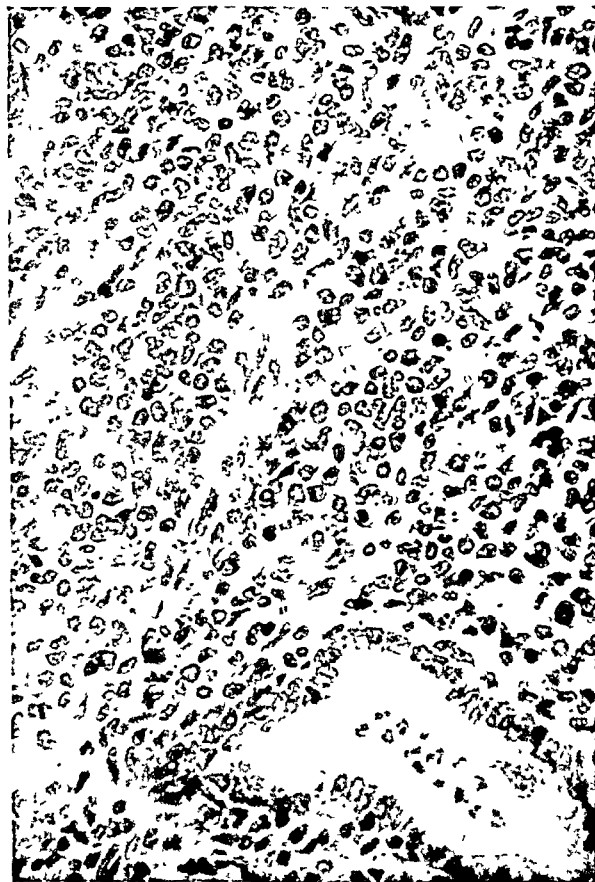


FIG. 5. Tumor cells in the mucosa (high magnification).

5. Temperature 98°F.

6. White blood count, 18,000.

During the course of the disease, the temperature varied from 98° to 103°F., white blood count varied from 13,400 to 18,000. Differential count showed 85 per cent polymorphonuclear leucocytes. Stool examination showed occult blood present. Free acid was present in the stomach content early and disappeared late in the disease. Roentgenographic findings showed a large dilated cap with distention of the entire duodenum and the first portion of the jejunum. The jejunum was almost completely obstructed and had a rather moth-eaten appearance. (Fig. 1.) The six-hour picture showed quite a bit of retention (Fig. 2). The twenty-four-hour picture showed considerable retention (Fig. 3).

The patient was transferred to my surgical service February 25, 1931. After consultation with Dr. Charles E. Kahlke, operation was

performed February 26, 1931 under local anesthesia at which time a first stage was done, bringing up the jejunal mass with a jejunos-

Microscopic examination: Sections of jejunum show extensive invasion of the mucosa and submucosa and to a moderate extent the



FIG 6. Tumor in the muscular coat (low magnification)

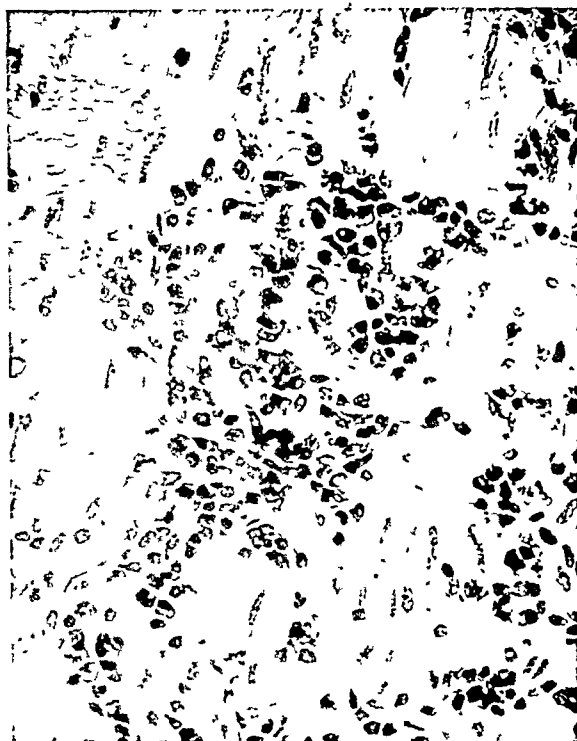


FIG. 7. Tumor in muscularis (high magnification).

tomy made both proximally and distally to tumor. March 5, a blood transfusion was done. March 7, second-stage operation was performed, at which time the tumor was resected and an end-to-end anastomosis made, with drains left in abdomen.

Patient soon developed a large carbuncular abscess over the sacrum which, with a complication of bronchopneumonia as well as a low grade fibropurulent peritonitis, caused her death March 11, 1931.

The pathologic report on the specimen shown in Figures 4-7 is as follows: Lymphosarcoma or lymphoma of jejunum. Gross: The specimen consists of a portion of jejunum 16 cm. long, over an area covering about 8 cm. of the same, the wall is considerably thickened. The mucosa is soft, friable, and hemorrhagically discolored. The tissue beneath the mucosa is considerably hyperemic and edematous. The peritoneal surface of the entire specimen, cut particularly in the area described above, is hemorrhagically discolored and covered by a red stringy material.

muscularis by a new growth of tumor cells which appear in large masses and replace the original tissue of the intestine. The main type of cell is round and resembles the lymphocyte. The nuclei are very chromatic, and mitotic figures are present. Some portions show vascular slits which are lined by the tumor cells. There are many areas of hemorrhage. The peritoneal surface shows considerable hemorrhage and is covered by a layer of fibrin in which are enmeshed endothelial cells, polymorphonuclear leucocytes and lymphocytes.

Reticulum stain revealed only few reticular tissue fibers extending in the tumor growth; but the fibers do not sufficiently surround the tumor cells as occurs in a reticulum-cell sarcoma.

Post-mortem examination was performed with the following significant findings: Metastasis of lymphosarcoma in the ovaries; fibrinopurulent peritonitis; bronchopneumonia in right lung; hypertrophy of heart; fatty degeneration of liver; acute splenic hyperplasia; acute hyperplasia of mesenteric lymph nodes.

CONCLUSIONS

Lymphosarcoma of the jejunum is an unusual finding, but in differentiating tumors of the jejunum it must be borne in mind. The most frequent tumor of the jejunum with which this growth might be confused is primary carcinoma. Secondly, the disease is usually fatal under the present treatment, namely surgery. Thirdly, I believe, in the future, the treatment of these cases involving the jejunum or any other portion of the gastrointestinal tract will be first, surgical exploration, then biopsy verifying the diagnosis, followed by intense x-ray radiation of the tumor as well as systematic raying of all the organs of the abdomen for possible

metastasis. Combination of both x-ray and radium therapy, the radium in form of distance packs as well as contact



FIG. 8.

radiation, have been known to give more or less permanent cures in lymphosarcoma cases.⁸

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ESSENTIAL SURGERY IN CHRONIC ULCERATIVE COLITIS*

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THE management of a widespread, disabling, often fatal disease, chronic ulcerative colitis, has been in the last ten years almost entirely relegated to the realm of medical treatment. Two factors conspired to bring this about. The mortality following operative interference in the past had been unusually high, due to the fact that surgeons did not understand the extreme permeability of a bowel carrying this infection and attempted to explore all cases, peritonitis frequently resulting from trauma, and to the fact that the preoperative and postoperative preparation was not properly emphasized. When the announcement was made that the disease was due to specific organisms and that vaccines and sera made from these organisms would cure the condition, the surgeon was glad to relinquish his attempts to combat the situation by radical means, and for ten years he has waited patiently to see the outcome of purely medical measures.

Four definite etiological agents have been postulated by different groups of observers, and each group seems equally convinced of the adequateness of their explanation and the complete efficacy of measures based on it. Because cases of amebic dysentery have been wrongly diagnosed as chronic ulcerative colitis one group has claimed that all cases are due to amebae. In England and Canada, and in some parts of this country, notably Baltimore, the theory of Hurst¹ and of Thorlakson² that the disease is related to bacillary dysentery has gained foothold, antidysentery serum being used. Larimore³ in this country called attention to McCarrison⁴ and Cramer's⁵ observations on the injury to intestinal mucosa and atrophy of lym-

phoid tissue resulting from vitamin deficiency and postulated that chronic ulcerative colitis was primarily due to an avitaminosis. Unquestionably the most popular theory in this country is that first enunciated by Barger⁶ in 1924, that the disease is the result of infection of the colon with a specific streptococcus and that vaccines and later⁷ sera from this organism are largely curative.

The burden of the present thesis is, briefly stated, as follows: Regardless of the final outcome of the discussion concerning the specificity of any etiological agent, and granting the value of recent discoveries, the results of treatment by present methods are nevertheless unsatisfactory. Surgical measures which have been in large part held in abeyance due to the high mortality formerly accompanying intervention and to present timidity in suggesting more radical measures in a condition urged to be purely "medical" have a wide field of usefulness which should be utilized. Such surgical procedures, which can be held to a lower mortality by proper application of new information concerning the pathology present will be useful in three ways: to cure the disease, to cure the patient if not the disease, to eradicate foci of infection in the zone of origin (the anal canal) as well as in distant foci.

Acceptation of this condition as one appropriate for medical measures only has resulted in a low hospital entrance rate, but a total of 38 cases diagnosed as chronic ulcerative colitis have entered Baylor Hospital (Dallas) during the past ten years. A survey of this group was made to bring out certain pertinent facts. Twenty-two patients were females, 16 were males.

* From the Section on Proctology, Baylor University Med. School, Dallas. Read before the Texas Surgical Society, Houston, November 17, 1931.

Two were under three years of age, the remainder were adults. Of this number 7 died in this hospital (18.4 per cent), practically one in every 5 cases. Of this 7 only one had any attempt to alleviate the condition surgically, and this was an improper procedure under an erroneous diagnosis of malignancy.

Practically all these cases were treated with vaccines, diet and irrigations, but 8 patients were treated surgically also. One was operated on for fistula with recovery of the colitis; one had a transverse colostomy for a long-standing left-sided infection, with complete recovery except for healed strictures; one ileostomy was done with recovery; 3 patients were operated on for infected hemorrhoids, 2 having anal ulcer, with improvement on discharge shown on the hospital chart.

One cecostomy was performed two months ago, with the result that a patient bedridden for eight months is now doing her own housework. With the exception of the one fatality already referred to, no patient who had any surgical procedure died or failed to improve, and of the 7 patients who did die of the condition, 6 were without the possible benefit of surgical interference.

In addition to those cases in whom the disease leads to a fatal termination, my own observations lead me to believe that there are thousands of these patients in this country returning to the doctor from time to time with new exacerbations of the disease or going from office to office or clinic to clinic with a constant chronic infection leading to impairment of health and invalidism.

The opinions of a group of surgeons most likely to see a volume of these cases have been recently sought to supplement the literature and these opinions will be quoted under two divisions: first those of the more conservative group who regard surgery as almost a last resort, second those who believe that operative measures should be much more frequently utilized than is now customary.

Under date of September 29, Dr. Fred Rankin wrote:⁸

Unquestionably, there is a certain time when one has to do a drainage operation for chronic ulcerative colitis. It should be in the intractable type of case which does not yield to any kind of treatment. Our experience with the acute, fulminating type has been very unsatisfactory; the mortality is very high and I question whether it is worth while doing it. I have never seen any advantage in doing a cecostomy or appendicostomy. We always do an ileostomy and I prefer to divide the bowel at the time. I think there is no question that we have had some very satisfactory results from ileostomy in the proper type of case at the proper time.

At the clinic ileostomy is used definitely in such complications as polyposis, strictures, extensive perirectal abscesses, etc. It is rarely used in the acute, progressively failing cases. In the past two years, ileostomy has been done in about three to four per cent of all cases of ulcerative colitis coming to the Clinic.

Under date of October 15, Dr. Jerome Lynch wrote:⁹

Answering your question, I believe there is a limited field for surgical procedure very seldom indicated in the acute cases, and then only following perforation, which has occurred in two instances in my experience.

In chronic cases where all other methods have failed, appendicostomy has given very satisfactory results, this operation I performed in the early days, 1914-1917; since then I have found surgery less frequently indicated.

In chronic cases where the infection has extended into the small bowel, ileostomy has given complete recovery. Roughly speaking about three per cent of the cases require surgical intervention.

In 1927, Fansler of Minneapolis wrote:¹⁰

Unless medical measures fail I do not believe that surgery is justifiable. During a remission there is no need of surgery and during an acute attack the operative mortality is high. The colon is highly infected, friable and should not be handled. Simple ileostomy with division well above the colon is the only procedure justifiable and even with this the operative mortality is about 50 per cent.

I find that a large group of experienced observers feel as I do that a condition so serious that it may and does bring about death or chronic invalidism, and prone to a variety of serious complications* should have the earlier benefit of surgical measures in addition to whatever else is done.

Lockhart Mummery and Sir Charles Gordon Watson, in a symposium on the subject in March, favored appendicostomy. Mummery said:¹

My experience of the treatment of ulcerative colitis, which is fairly extensive, is that appendicostomy is curative, provided it is performed early, that is to say, before the bowel has been severely damaged. At St. Mark's Hospital we have large numbers of these cases and in the course of the last few years we have tried all the different treatments for the condition, but we have always come back to appendicostomy as the one method to be relied upon, not only to save the patient's life, but also to prevent frequent recurrences.

When patients are treated by medical men only, it often results in their being laid up in bed or undergoing treatment for many months in the year, and this in these busy days means that they are seriously handicapped. I have had to operate in many such cases and perform appendicostomy because the patients could not afford the time for the long and tedious treatments which were necessitated by the frequent recurrences. There is apparently no means of preventing recurrence, but if each recurrence is promptly and adequately treated, the tendency in time disappears.

If an appendicostomy is performed, the opening should not be closed until the patient has been for a full year without treatment and without any recurrence.

Gordon Watson said in the same symposium:¹

Except in the mild cases, he (the speaker) always performs appendicostomy; he did not think one could deal with the proximal colon

adequately by the rectum. He regarded appendicostomy as a definite life-saving measure in many cases.

Dr. Harvery Stone is quoted as saying in 1929:¹¹

Treatment is in general unsatisfactory. Three classes of cases may require surgical measures: (1) the relatively mild group that fail to improve in spite of medical methods and result in chronic invalidism; (2) the persistently recurrent cases; and (3) the fulminant cases with great loss of weight, marked anemia, and asthenia. In these three types of the disease, operation should be performed before the general condition becomes critical and before systemic infection develops. In general, the operation of choice is ileostomy, but under special conditions other surgical procedures may be preferable.

Dr. Louis Hirschman of Detroit recently wrote:¹²

After seeing for many years cases of true ulcerative colitis which have persisted in spite of all forms of dietary, vaccine, medicinal and physiotherapy I have become convinced that surgery has a position of prime importance in the treatment of chronic ulcerative colitis.

In the acute fulminating type ileostomy is often a life-saving measure. It is far better to perform a cecostomy or ileostomy on a patient suffering from ulcerative colitis who might possibly have been materially improved by non-surgical measures than to wait too long. When a patient is emaciated, dehydrated and exsanguinated the operative risk is of course materially increased.

The majority of cases that come under my observation consult me only after a long period of non-surgical care, so fully 75 per cent of those under my care are advised to have surgical intervention.

Dr. Dan Jones of Boston, under date of October 15 wrote as follows:¹³

I am just as sure as I have always been that there is a field for surgical procedure in these cases. I believe that an ileostomy should be done in a few acute cases, perhaps rarely in a fulminating case, and always in a chronic case which is going steadily down hill in spite of any treatment. In acute cases it should be

* Bargen (*Arch. Int. Med.*, Oct. 1929) states that 268 complications occurred in 693 cases at the Mayo Clinic, including polyposis in 10 per cent, stricture in 8.5 per cent, arthritis in 4.33 per cent, perirectal abscess in 3.7 per cent, endocarditis, splenomegaly, renal insufficiency, each 1 per cent, perforation 2.6 per cent and malignancy 2.16 per cent.

done when there is much bleeding and many movements pulling the patient down faster than he can possibly stand. I do not regard appendicostomy or cecostomy as sufficiently helpful to be of value. It is difficult for a surgeon to estimate the percentage requiring surgery. Medical men will hold on to these cases so long that I believe I operate upon nearly 75 per cent of the cases I have been asked to see.

In 1928, Thorlakson of Canada stated:¹⁴

The complications of ulcerative colitis are arthritis, haemorrhage, perianal abscess, stricture, polyposis, perforation and malignancy. As the nature of the microorganism responsible for the condition is not known, the treatment has not been standardized. The author has found a simple caecostomy for irrigation of great value. Transverse ileostomy is rarely necessary, but is of benefit in selected cases. Its indications are repeated profuse colonic haemorrhage, generalized polyposis, and a long-standing cases in which the colon has been converted into a useless fibrous tube.

It is apparent that there is a variance of opinion as to just what procedure should be done if surgical intervention is contemplated. My own judgment is that the mild but chronic case in which vaccines, sera, diet and rest fail to bring about remission promptly, or in those in which recurrence occurs, an appendicostomy or cecostomy is indicated. It seems reasonable to assume that this is the type of case which is not now submitted to surgical judgment, and it is possible that it is for this reason that some of the authorities quoted reply entirely on ileostomy.

In fulminating cases, where intervention is necessary to save life, or in any case complicated by polyposis, malignancy, hemorrhage, etc., a transverse ileostomy seems definitely desirable.

Observance of several tremendously important surgical principles, which have been brought out by the intensive study this condition has been given in recent years, should do much to keep the mortality within proper limits. The first is the use of one or more preliminary transfusions

of blood, coupled with a smooth low residue diet and fluids by clysis. The second is complete avoidance of trauma to the colon in the laparotomy, best accomplished by the use of spinal anesthesia for relaxation, careful handling and no exploration. The third is prevention of soiling the wound until it has had opportunity to heal per primam, in other words the appendicostomy or cecostomy is best left closed for a period of five days to one week after the laparotomy.

The prevalence of recurrence in connection with chronic ulcerative colitis has enforced the suggestion that the etiologic organisms are retained between attacks in body foci. While the general opinion has favored these locations hallowed by custom, teeth, tonsils and sinuses, there are several significant facts which indicate that lesions in the anus itself may harbor the organism. The disease begins in the lower rectum always, each recurrence originates in the same area. Anal ulcer and cryptitis leading to perirectal abscess and fistula are not uncommon findings (see note) and are not sufficiently explained by the assumption that they are secondary to infection above.

I find that Dr. Hirschman agrees¹² that ulcerative colitis may be an ascending infection from anal foci.

It is suggested therefore that when the acute exacerbations are arrested, demonstrable infective pathology in the anus be surgically eradicated.

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[For Remainder of References see p. 394.]

ACUTE INTESTINAL OBSTRUCTION CAUSED BY IMPACTED GALLSTONES

WITH CASE REPORTS*

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INTESTINAL obstruction caused by the impaction of a large gallstone in the lumen is rather rare and warrants

At St. Margaret's Hospital in a series of 172 cases operated upon for intestinal obstruction there were only 2 due to im-

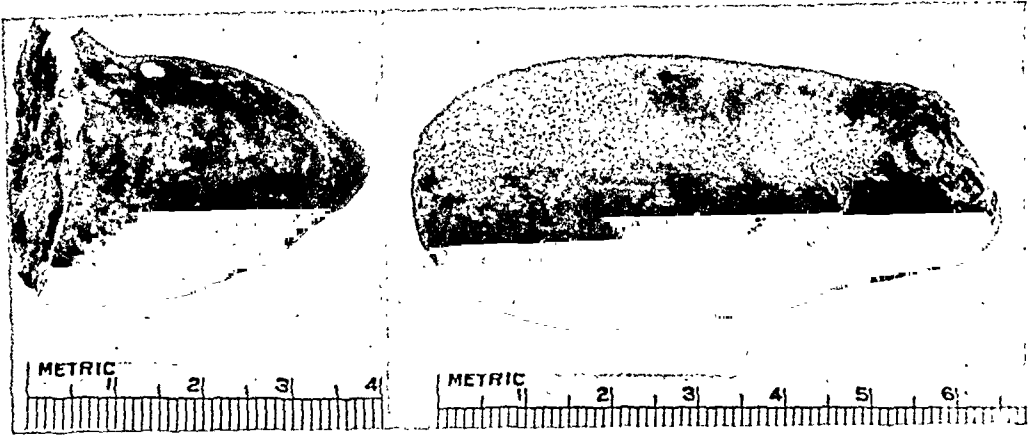


FIG. 1. Large, conical shaped stone from Case 11, measuring 5 cm. in length and 3 cm. at its base. Note pointed projection on superior border which caused perforation 49 inches distal to fistulous opening in gall bladder which is shown in Figure 3.

FIG. 2. Large single stone from Case 1, measuring 7 cm. in length and from 2.5 to 3.5 cm. in diameter, which completely occluded lumen of gut.

special interest, in that an early diagnosis and early operation will markedly decrease the mortality rate.

A review of the literature shows the first recorded case was that of Bartholin¹ in 1654. Later in 1890 Courvoisier² analyzed all reported cases prior to that date and found 131. In 1914 Wagner³ made an exhaustive study of the literature and found 334 cases causing obstruction.

From the British Medical Association⁴ a survey of 3064 cases of intestinal obstruction reported from seven hospitals in 1925, impacted gallstone was the cause in only 28 cases or less than 1 per cent, the most frequent being hernia, intussusception, malignancy, adhesions, volvulus and internal strangulation.

packed gallstones. Powers⁵ found 4 cases in 179 cases of intestinal obstruction. Moore⁶ states from all available statistics that gallstones cause from 1 to 2 per cent of all intestinal obstruction. Martin⁷ reports 1 case out of 280 cases of intestinal obstruction. So all statistics seem to be within a normal limit except the earlier views of Courvoisier, who gave a much higher estimate.

The recent literature includes only 3 cases which have been reported, one by Jackson and Ewell⁸ and two by Siewerth.⁹

Gallstones entering the intestinal tract usually admit themselves by one of two methods: (1) by perforation from the gall bladder through the duodenal wall, of (2) by entering through the common duct. Our 2 cases chose the first route, by first producing a cholecystitis and cholelithiasis

* Read before the Kansas City Southwest Clinical Society, Kansas City, Kansas, Sept. 1, 1931.

followed by ulceration, erosion and pericholangitis. This was followed by the formation of adhesions between the gall bladder and neighboring viscera, and perforation occurring within these adhesions.

The duration of and the presence of symptoms seems to be questionable from recorded reports. Reimann and Bloom¹⁰ reported a case following autopsy finding, the patient having died of empyema following lobar pneumonia. The postmortem examination presented a biliary fistula between the gall bladder and the pyloric portion of the stomach. A calculus about 2 cm. in diameter was found in a cystic cavity within the stomach wall. Though this patient was jaundiced there was no other history of gall-bladder disease. According to the history of both of our cases, they relate the presence of a sudden sharp pain in the region of the gall bladder, which was followed by continued nausea and vomiting. Previous to this attack they gave a history referable to gall-bladder disease. Neither of our patients was jaundiced due to the fact that the stone perforated through the wall of the gall bladder at the fundus into the duodenum at about the middle third.

The extent of passage down the intestinal tract is variable anywhere from the point of entrance to an exit at the rectum. Murphy¹¹ states that, of 125 cases, 70 after various and repeated colics, emesis, peritonitis, ileus, etc., were cured spontaneously by the passage of the stones per rectum. In such cases they may be single or multiple stones, usually of small caliber. Both of our cases were single, large stones.

In Case I the stone lodged $3\frac{1}{2}$ feet from the adhesions of the gall bladder to the duodenum. In Case II the stone lodged 49 inches from the adhesions of the gall bladder to the duodenum. Once the diagnosis of obstruction due to impacted gallstones is made, immediate operation is imperative, and the duration as brief as possible. In the majority of cases a simple enterostomy is sufficient, and it is our belief that a cholecystectomy should not be considered until a later date. The best

method of closing the enterostomy seems questionable. Brown¹² advocates recovering the stone through a transverse incision

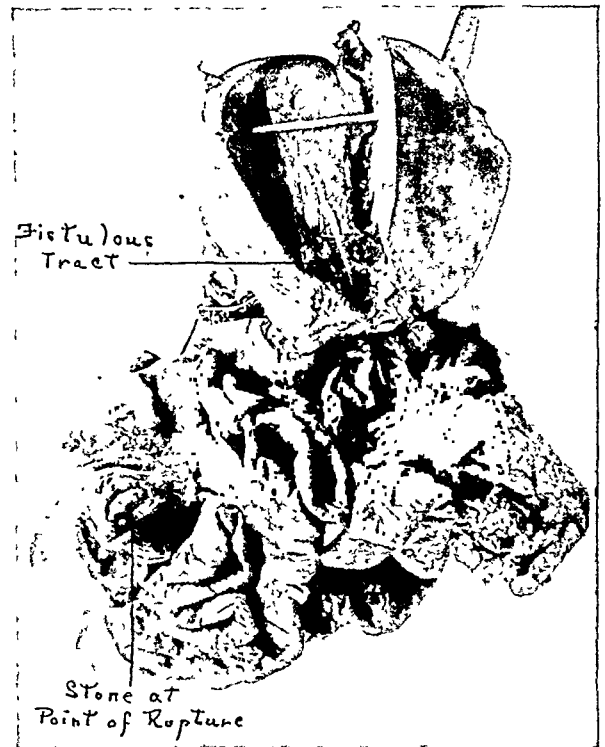


FIG. 3. Specimen en masse from Case II. Liver is sectioned, with probe passing through fistulous tract from gall bladder into duodenum. In lower left corner we see stone (Fig. 1) has ruptured through gut wall, presenting pointed projection.

in order to avoid such constriction of the intestinal lumen as occurs when a longitudinal incision is closed and inverted. Davis¹³ advises a transverse closure of a longitudinal incision. In Case I we made a longitudinal closure of a longitudinal incision.

CASE I. Mrs. L. D., white female, aged fifty-six, entered St. Margaret's Hospital on December 31, 1930 with a chief complaint of vomiting.

Present Illness: About one year ago patient had an attack of vomiting with pain in the right side along the costal margin. This pain was associated with much gas. During this sickness she was admitted to a diagnostic clinic, leaving much improved, with the diagnosis of gall-bladder disease. The patient enjoyed very good health until Christmas day, when following dinner she began to vomit.

She had no definite pain, but a generalized abdominal discomfort, and was unable to retain any food or liquid on entering the hospital. Patient denies a history of ever having been jaundiced. She has no substernal burning following vomiting. Bowel movements have been very irregular, being forced by enemas. She has voided only small amounts of urine. The patient has lost no weight in past three years. Her history is otherwise negative.

Physical examination reveals a large woman, weighing 155 pounds, good nutrition, skin very dry, no edema, no jaundice, and no general glandular enlargement, thyroid not enlarged, joints negative, extremities negative and examination of heart and lungs negative.

Daily reports on the patient are as follows: December 31, 1930: hypodermoclysis of 5 per cent glucose in 2000 c. c. of saline. Einhorn tube inserted with gastric lavage every two hours. Blood count: red blood cells 6,270,000; white blood cells 21,350; polymorphonuclears 83 per cent, hemoglobin 90 per cent. Blood chemistry: sugar 206, non-protein nitrogen 117.6, urea nitrogen 9.4, creatinine 3.2, carbon dioxide combining power 57.4, calcium 11.5 and phosphorus 4.2.

January 1, 1931: Urinalysis (catheter specimen): specific gravity 1.010, alkaline reaction, negative for albumin and sugar, few red blood cells and 3 plus white blood cells. Vomiting continued. Two thousand cubic centimeters of saline with 5 per cent glucose were given by hypodermoclysis. Acriflavine, grains $\frac{1}{2}$ t. i. d.

January 2, 1931: 2000 c. c. of 2 per cent glucose given by hypodermoclysis; 2000 c. c. normal saline given by hypodermoclysis. Patient showed some improvement. Vomiting is decreasing.

January 3, 1931: 2000 c. c. of 2 per cent glucose given by hypodermoclysis; 2000 c. c. of saline given by hypodermoclysis. Blood chemistry: sugar 135, non-protein nitrogen 53.1, urea nitrogen 6.7, creatinine 1.1, carbon dioxide combining power 70, amino acids 6.2 mg.

January 5, 1931: Patient is some better. Feces examination shows some fat globules. Chemistry examination: amino acids 5.2 mg.

January 4, 1931: 4000 c. c. of normal saline given by hypodermoclysis. Patient's condition unchanged.

January 6, 1931: Patient is much better.

January 7, 1931: Liver function test five minutes 45 per cent, thirty minutes 5 per cent.

January 8, 1931: Urine is negative. Blood culture: no growth in four days. Patient is much better.

January 9, 1931: Patient is greatly improved.

January 11, 1931: Patient is much improved.

January 14, 1931: X-ray gall-bladder visualization with tetra iodide. Report is as follows: "The radiographs taken twelve and fourteen hours fail to show a shadow of the gall bladder. There is a peculiar rounded shadow occupying an abnormal axis for the gall bladder, but which suggests in its detail calcification of the wall of a large gall bladder. This shadow's identity is questionable."

January 15, 1931: Patient's condition excellent.

January 18, 1931: Patient is discharged.

Patient was readmitted to St. Margaret's Hospital on January 29, 1931, complaining of vomiting which began on the night of January 28 and continued throughout the night. The vomitus on admission to the hospital was bile stained. Two thousand cubic centimeters of normal saline were given by hypodermoclysis.

January 30, 1931: Urinalysis negative. Two thousand cubic centimeters of normal saline given by hypodermoclysis.

January 31, 1931: Patient is much better.

February 1, 1931: Patient is much better. Two thousand cubic centimeters of normal saline given by hypodermoclysis.

February 3, 1931: X-ray examination. Patient is seen without a preliminary meal, and is able to take only a small amount of opaque media. First bolus is projected into the duodenum, visualizing a large triangular duodenal bulb. In the semirecumbent position the media gravitates to the right of the spinal prominence and the upper jejunum fills rapidly. Definite dilatation of the upper jejunum is apparent and regurgitation is observed. The appearance of the jejunum does not suggest an absolute obstruction.

Plates: "Films of the abdomen show an incomplete obstruction of the jejunum on the left side of the abdomen."

February 4, 1931: 2000 c. c. of normal saline given by hypodermoclysis; 2000 c. c. of 5 per cent saline with 2 per cent glucose given by hypodermoclysis and two 50 c. c. ampules of 50 per cent glucose given intravenously. At no time through the stay in the hospital was visible peristalsis noted.

February 5, 1931: Patient was operated upon. A preoperative diagnosis was made of high intestinal obstruction due to impacted gallstone.

Operation was as follows: Under amytal, novocaine and ether anesthesia, a supra-umbilical midline incision was made. On opening the peritoneum a large amount of bile-tinged fluid was found, and a markedly dilated small intestine. The stomach and pancreas revealed nothing abnormal on examination. The small intestine which presented itself into the wound was distended and engorged. On tracing the distention there was found a collapsed portion about the distal portion of the jejunum and on palpation there was found to be a hard mass about the shape and size of a duck egg, completely obstructing the lumen of the gut. The gut distal to the mass was collapsed. Intestinal clamps were applied distal and proximal to the mass and a longitudinal incision about 5 cm. in length was made opposite the mesentery. The mass was easily delivered, and thereby exposed the intestinal mucosa, which from its condition showed that the stone has been in its present position sometime. But the condition (Fig. 2) of the gut did not warrant a resection. The incision was closed with catgut longitudinally. The gall bladder was not explored. The wound was closed in layers without drain and patient returned to her room in good condition.

February 6, 1931: 4000 c. c. saline was given by hypodermoclysis.

February 9, 1931: Patient's postoperative convalescence is excellent. Abdomen is soft and in excellent condition.

February 10, 1931: At 1:30 P.M. patient was awakened by a very sharp, severe pain in the lower abdomen. She was perspiring and looked as though she were in great pain. The abdomen was soft, no rigidity, but there was tenderness on firm pressure. The abdomen is tympanic, but no marked distention. At 2:00 P.M. the patient began having chills. Pain became more severe and abdominal rigidity was present. With a diagnosis of intestinal perforation the abdomen was reopened.

Operation: The original surgical wound was reopened. The coils of the jejunum presented themselves and were distended. No exudate was visible. On examination of the gall-bladder region and the under surface of the liver, a large amount of seropurulent fluid was present

with an abundance of plastic exudate. The gall-bladder wall was injected and thickened, with many adhesions between it and the duodenum. A drain was placed under the liver and stab drain placed in the pelvis. The pelvic wound was closed, and the patient taken to her room in poor condition. Her condition grew rapidly worse and the patient died at 9:00 P.M. the same day.

Autopsy findings were as follows: (Only the organs of interest will be noted). The peritoneal cavity contained about 1500 c. c. of purulent fluid which contained abundant fibrin. Just below the surgical incision there is a part of the jejunum upon which an enterostomy has been performed. Three and one-half feet from the adhesions of the gall bladder to the duodenum there is an opening through which the intestinal contents have access to the peritoneal cavity. The gall bladder appears connected to the duodenum. The adhesions between the gall bladder and the duodenum upon dissection revealed a small fistulous tract present between the gall bladder and the duodenum, measuring about 5 mm. in diameter. The gall-bladder wall is markedly thickened. No stones are present.

CASE II. Mrs. M. T. was admitted to St. Margaret's Hospital on March 31, 1931. She is a colored female, aged fifty-eight. Chief complaint is pain and vomiting.

Present illness dates back to about four weeks ago, when the patient had been having a dull pain in the epigastrium. One night while asleep she was suddenly awakened by a sharp pain in the epigastrium which was followed by vomiting, and continued until admission to the hospital. Patient has been unable to retain any food and only a small amount of liquids. Patient describes the vomitus as being of dark brown color and containing blood. The stools were tannish in color. She has lost an appreciable amount of weight in the past month. Due to the physical condition of the patient we were unable to obtain more history.

Physical examination revealed an extremely thin colored woman with an essentially negative examination, except for the abdomen which was full. No ascites. Pain was diffuse but most marked in the upper quadrant. No masses were felt. Liver and spleen were not palpable due to extreme tenderness.

Daily reports on the patient are as follows: March 31, 1931: Vomitus benzdine test

positive for blood. Red blood cells 4,500,000, hemoglobin 70 per cent, white blood cells 9150, polymorphonuclears 75 per cent. Urine was essentially negative. Three thousand cubic centimeters of saline was given by hypodermoclysis; 50 c. c. of 50 per cent glucose was given intravenously.

April 1, 1931: 3000 c. c. of saline was given by hypodermoclysis, 50 c. c. of 50 per cent glucose given daily.

April 2, 1931: Patient's condition does not improve and does not warrant an exploratory laparotomy.

April 4, 1931: Patient is growing weaker with increasing pain. She is cold and clammy and has slight distention.

April 5, 1931: Patient died at 3:00 A.M.

Autopsy findings were as follows: Upon opening the peritoneal cavity the peritoneum contained a large amount of fibropurulent exudate as well as some liquid fecal material. About 2000 c. c. of fluid are present in the peritoneal cavity, so that the surface of the peritoneum both in the lesser and greater peritoneal cavities is covered with a fibropurulent exudate, and numerous areas of hemorrhage are present, especially in the lesser peritoneal cavity over the pancreatic region. It is noted that the entire transverse colon is adherent to the gall bladder region. The liver over the gall bladder appears rather firm. The gall-bladder wall is markedly contracted and upon removal of the fluid from the peritoneal cavity there is seen a perforation in the small intestine (Fig. 3) about the lower portion of the jejunum which contains a large stone. The gastrointestinal tract shows a fistulous opening in the duodenum and a large stone, rather cone shaped, with the smooth portion pointing upwards. About the base the stone appears rather rough and irregular; the intestine around the stone has become necrotic and is ruptured. The stone presented itself about 49 inches distal to the fistulous opening of the gall bladder into the duodenum. At this point the wall is very thin and the erosion measures 2.5 by 1.5 cm.

COMMENTS

The presence of a gallstone or stones in the intestinal tract without the presence of symptoms is an established fact, in that they may lie dormant for a long period of time and never cause symptoms

or death, or they may be passed by rectum without symptoms.

Our first case was obviously a case of intestinal obstruction, the perforation from the gall bladder into the duodenum occurring about one year before admission into the hospital. In Case II the entrance of the gallstone into the intestinal tract was four weeks before admission to the hospital. The perforation of the intestine, resulting in peritonitis, occurred at night during sleep and the day before entering the hospital. There was a fleeting obstruction for four weeks. There was no history of gall-bladder disease which aided in making the diagnosis of obstruction due to gallstones.

Acute intestinal obstruction caused by impacted gallstones is more infrequent than one would judge before reviewing the literature.

Regardless of the mode of entrance into the intestinal tract, the symptoms are essentially the same except the presence or absence of jaundice. The duration of time up to a partial or complete obstruction is a variable factor. In our first case the time was one year and the second was four months. Once the diagnosis is made an early operation is imperative, the extent of which varies according to the condition of the patient, and regardless of the severity of the condition of the patient, preoperative and postoperative administration of saline should be given subcutaneously and intravenously.

Case I was entered at St. Margaret's Hospital on the surgical service of Dr. C. C. Nesselrode and Case II on the surgical service of Dr. M. J. Owens.

LITERATURE

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3. WAGNER, A. *Illeus durch Gallensteine*. *Deutsch. Ztschr. f. Chir.*, 130: 353, 1914.
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[For Remainder of Literature see p. 412.]

TRANSVERSE INCISION IN 100 CONSECUTIVE APPENDECTOMIES*

REGINALD A. CUTTING, M.D., M.A., PH.D.

NEW ORLEANS

IT would almost seem as if any discussion of appendicitis and appendectomy undertaken *anno Domini* 1931 should

the operation of appendectomy and for this reason, if for no other, the repetition would seem justifiable.

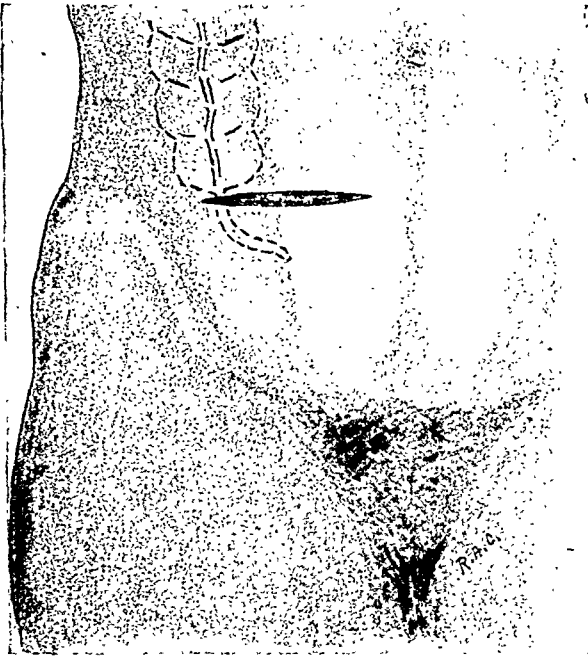


FIG. 1.

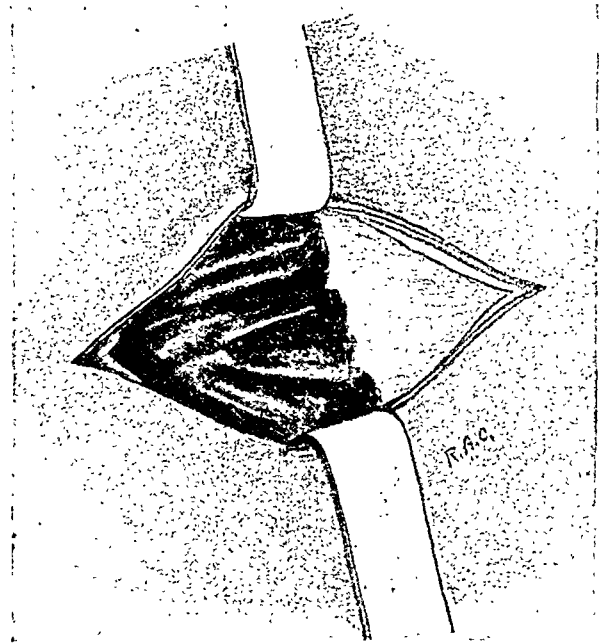


FIG. 2.

be prefaced by an apology for again dragging to the fore a subject already so thoroughly examined that its garments seem threadbare and devoid of ability further to conceal any clinical secrets at all. This would seem especially so in view of the fact that the present discussion purports to contribute nothing essentially new, but only to present a new series of cases and to direct attention to certain considerations of technical and clinical significance which are new only in their arrangement and method of presentation. The fact remains, however, that of all the major procedures in surgery there is none which is more frequently performed by immature and unskillful hands than

For a number of years, I have been convinced that the transverse incision as described by Davis¹ in 1906, frequently called the "Davis incision" is the most rational abdominal incision for use in performing simple appendectomy.² Naturally for exploratory laparotomies in which the preoperative diagnosis is very much in doubt, or in which there is reason for believing that more extensive procedures than appendectomy will be required, a "median," "paramedian," or some other incision is usually preferable, but, on

¹ Davis, C. G. A transverse incision for the removal of the appendix. *Ann. Surg.*, 43: 106, 1906.

² This incision is said by Davis to be a modification of an incision described by J. W. Elliot (*Boston M. & S. J.*, 2: 433, 1896).

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the other hand, the transverse incision does not so limit the field of operative attack as to prevent dealing on occasion with abnormalities which simulate, clinically, the picture of acute appendicitis: Meckel's diverticulitis, tumors of the cecum and terminal portion of the ileum, tumors of the ovary, fallopian tube and uterus, low mechanical ileus, extra-uterine pregnancy and the like.

In view of the fact that the incision under discussion is perhaps not familiar to many persons who otherwise might use it and eventually come to regard it in the same high esteem as I do, I have decided to review the technical steps in its performance and also to present a clinical survey of the operative, convalescent and subsequent histories of the last 100 consecutive cases in which I have used the incision. All the cases were operated upon from the services of Dr. Alton Ochsner and Dr. I. M. Gage in the Charity Hospital of New Orleans, and I am indebted to the Superintendent and Officers of the institution for permission to make use of the hospital records of the cases in preparing this survey.

TRANSVERSE APPENDECTOMY INCISION

When properly performed, the transverse appendectomy incision about to be described presents the following noteworthy advantages: 1. The skin incision closely conforms to the natural skin cleavage lines of the anterior abdominal wall. This consideration is important in that the natural tendency of the finished skin wound is not to gape but rather to remain closed, and furthermore, when fully healed to be only slightly visible provided accurate apposition of wound edges has been primarily secured and subsequently maintained. 2. The division of the deeper structures is made in accordance with approved anatomical principles—in other words, there is no division of muscle fibers, aponeuroses are split rather than cut, and the completed abdominal incision tends to be drawn together by the natural

stresses exerted by the elasticity and muscular pull of its component parts; these parts also imbricate themselves in such a manner as to insure additional strength. 3. It is correctly placed with reference to the surface anatomy of the appendix; the opening in the abdominal wall is directly over the base of the appendix and cecum, and, therefore, the margins of the wound do not have to be retracted this way or that in order to expose the structures to be manipulated; this is true to the same extent of no other appendectomy incision. 4. When ordinary care is used there is no danger of wounding important structures and thus interfering with the subsequent integrity of the anterior abdominal wall; the incision, being transverse, parallels the general direction of the intercostal nerves, which supply the intrinsic musculature of the anterior abdominal wall, and the epigastric vessels, which are the only blood vessels of any size in the general region, are well beyond the medial end of the incision. 5. The incision is of ample size, when made as suggested, to permit moderately extensive exploratory examinations, especially exploratory examinations of the uterus and adnexa, and can be conveniently enlarged when necessary to take care of unusual and unexpected abnormalities; the primary usefulness of the incision is not, however, as an exploratory one.

It is of the utmost importance that the incision be placed properly, both as to its direction and also as to its level. The proper level is that of the anterior superior spine of the ilium. The proper direction is exactly transverse, that is, strictly at right angles to the long axis of the body, and the incision is so planned that its middle corresponds as nearly as possible with the right linea semilunaris, that is, with the outer border of the right rectus abdominis muscle (Fig. 1). When about to make the incision it is my custom to locate the anterior superior spine of the ilium accurately with the thumb of the left hand and place the tip of the index,

or, better perhaps, the middle finger of the same hand, in the region of the median line of the body and strictly on the same

oblique aponeurosis. This aponeurosis is cut transversely in the same direction as the original skin incision and somewhat

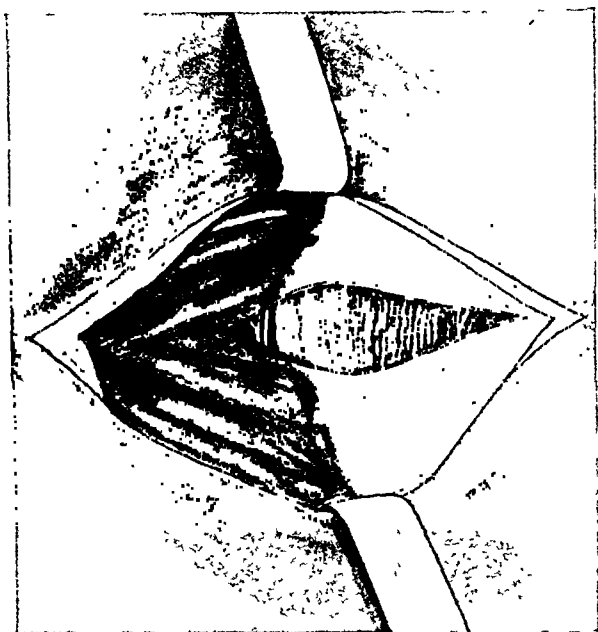


FIG. 3.

level as the thumb. The imaginary line connecting the tip of the thumb with the tip of the finger represents the line of the incision. By spreading the thumb and finger slightly the proper degree of tension can be exerted on the skin to make it sufficiently taut to be properly cut with the knife. The knife is grasped in the right hand, and an incision of the desired length is made with a single sweep of the scalpel. The length of the incision may, of course, vary in accordance with the preferences of the individual operator, and also with the estimated thickness of the anterior abdominal wall, because when the anterior abdominal wall is thick a longer incision is ordinarily required than when the abdominal wall is thin. Because I dislike working in cramped quarters and also because I believe that an adequate incision is to the patient's distinct benefit, it is my custom to make the incision at least 3 inches in length in all cases. The incision is carried directly to the underlying aponeurotic plane which consists of the fibers of the external

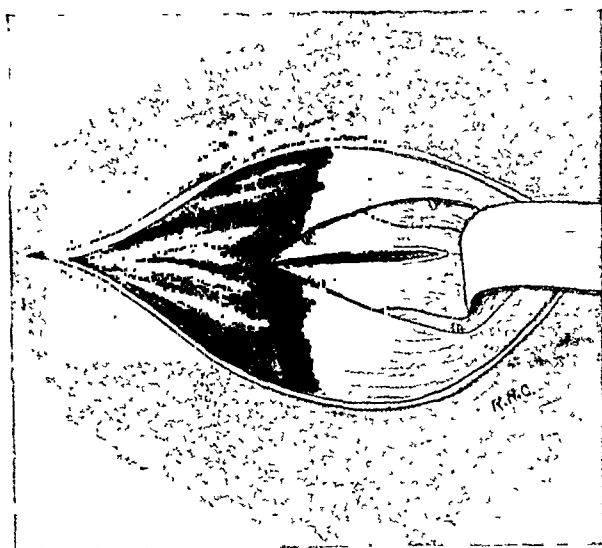


FIG. 4.

obliquely to the course of the fibers of which it is composed. By this maneuver is exposed the deeper aponeurotic plane which consists of the anterior sheath of the rectus muscle in the medial one-half of the wound and the aponeurosis of the internal oblique muscle in the lateral half (Fig. 2). As previously stated, in the middle of the incision is the linea semilunaris. It will be noted when this incision is used in a series of cases that the width of the rectus muscle varies considerably from patient to patient, and although one should, when possible, plan the incision so as to be accurately bisected by the linea semilunaris, one may be surprised to find on actually exposing the linea semilunaris in any given case that it lies in a somewhat different right or left position from that which was originally expected. It should also be noted that the fibers of the internal oblique muscle are largely aponeurotic as they lie in the depths of the incision, except in the extreme lateral angle of the wound. The proportion between the muscular segment of the internal oblique muscle and its aponeurotic

portion varies in different individuals, and not infrequently the entire expanse of internal oblique which is exposed in the

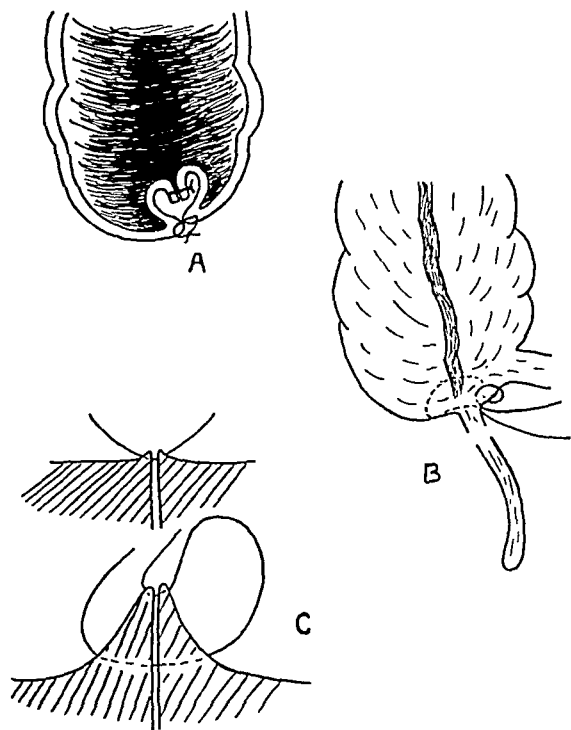


FIG. 5.

incision is found to be aponeurotic and not muscular.

The amount of hemorrhage which is encountered during the initial incision varies, of course, from patient to patient and is controlled by the prompt use of hemostat and ligature; there are no blood vessels of considerable size or constant location in the field. The next step in the procedure, however, consists in incising the anterior sheath of the rectus exactly transversely; i.e., in the same direction as the original skin incision, and in this portion of the incision there are two minor blood vessels which are of rather constant location. Toward the medial angle just beneath the anterior sheath of the rectus muscle there usually occurs a small vessel which is a branch of the deep epigastric artery and which courses in the long axis of the body, parallel with the fibers

of the rectus abdominis muscles and perpendicular to the line of incision. Just within the linea semilunaris and coursing also just beneath the anterior sheath of the rectus muscle there occurs rather constantly another small vessel which is also a branch of the deep epigastric artery, the course of which is also perpendicular to the line of incision (Fig. 3). Frequently both of these vessels are of about the same size, although occasionally one is much larger than the other, and occasionally either the one or the other seems to be absent. If the location of these two small vessels be borne in mind while incising the anterior sheath of the rectus muscle the severed ends of the vessels can be immediately caught with hemostats and the technical excellence of the operative procedure can thereby be improved. These vessels are not really larger than the vessels commonly severed during the performance of any other operative procedure but are so constant in location as to deserve a word of mention.

After the anterior sheath of the rectus muscle has been incised as far as the linea semilunaris the blunt points of a Mayo scissors are introduced into the tissues just at the lateral border of the rectus muscle and are slightly separated in order to uncover the line of cleavage between the posterior surface of the rectus muscle and the transversalis fascia. As soon as this line of cleavage has been recognized, the finger of the gloved hand is introduced posterior to the belly of the rectus muscle and insinuated beneath the muscle towards the midline, sweeping the finger slightly backward and forward to free the muscle of its friable posterior attachment. As soon as this manipulation has been performed a Parker, or "ribbon," retractor is hooked over the lateral edge of the muscle and the muscle belly is gently retracted medially so as to expose a triangular shaped area of the transversalis fascia (Fig. 4). If the incision has been performed at the proper level there

is no posterior rectus sheath at this point, although occasionally if the incision has been made a little too high and medial retraction of the rectus muscle is performed rather vigorously in cases in which the attachments of that muscle to its sheath are not too firm, the fold of Douglas, or linea semicircularis, which represents the most caudad portion of the posterior rectus sheath may be seen in the upper portion of the wound.

The transversalis fascia and peritoneum now tend to pouch into the wound. Sometimes the transversalis fascia is thick and fibrous, sometimes veil-like and friable in this locality. In case transversalis fascia and peritoneum are thin, coils of intestine may be plainly seen outlined beneath them. Ordinarily the deep epigastric vessels are not seen because they are too near the midline at the level at which the incision is made; however, if the incision is inadvertently made too low or if, on the other hand, the vessels course a little more laterally than usual the epigastric vessels may be seen in the medial angle of the incision. At all events they should be looked for lest they be inadvertently incised during the next procedure.

The next process consists in opening the abdominal cavity. The incision is started through the pouching transversalis fascia and peritoneum with the precautions commonly used when opening into the peritoneal cavity; i.e., picking up the layer consisting of transversalis fascia and peritoneum between two pairs of tissue forceps, alternately releasing and applying first one and then the other of these forceps in such a way as to allow any fragments of omentum or bowel which may have been picked up by chance to disengage themselves and fall away from the lower surface of the parietal peritoneum, then carefully nicking the membrane with a knife, inserting a finger into the nick thus made, and extending the incision by cutting with a knife along the finger as a guide. The incision is

made strictly transversely as were both of the previous incisions; viz., the incision through the skin and through the anterior sheath of the rectus muscle. Occasionally the rectus sheath is so wide that this maneuver gives ample exposure; usually, however, such is not the case, and the incision is next carried laterally directly through the linea semilunaris. As soon as the linea semilunaris has been cut the natural course of the aponeurotic fibers of the internal oblique and transversus muscles is respected. The incision is enlarged from this point outward by blunt dissection with the handle of the knife, the blade only being used to divide the transversalis fascia and peritoneum.

In most cases the structure which presents in the wound after this manipulation has been performed is either the omentum or the cecum. If omentum presents in the incision, however, it does so merely because it overlies the cecum, and the cecum may be exposed by displacing the omentum toward the midline. The cecum is readily recognized, of course, by the presence of its tinae coli, but even before the tinae are seen the cecum is usually recognizable both by its sacculated appearance, by its size, and also by the fact that it is whiter in color than any loops of small intestine which may appear beside it. The cecum is now grasped between the thumb and index finger and is pulled upward, outward, and cephalad. If the cecum is mobile, the caput ceci is displaced by this motion so that it lies directly in the abdominal incision, and if the appendix is not anchored to other structures by a congenital band of fibrous tissue or acquired adhesions it is rendered immediately visible. If this manipulation, however, does not succeed in bringing the appendix directly into the wound the base of the appendix can be located without further ado by tracing one of the tinae coli toward the pelvis. The point at which this landmark is lost accurately represents the base of the appendix, except in those rare cases in

which the area is overlain or distorted by abnormally placed tissues.

No mention need here be made of the various methods of dealing with anatomical variations in the position or environs of the appendix, because such methods as are suitable for dealing with these anomalies when any other incision is used are equally effectual with this one. A word, however, may be said with regard to the rational manner of dealing with the stump of the appendix after the appendix proper has been removed. I cannot believe that any technique of treating the stump of the appendix is rational if it does not include some sort of inversion. I am aware that many surgeons do not agree and habitually practice simple ligation of the stump, returning the cecum forthwith to the abdominal cavity. Although I am not prepared to contend that such a procedure is particularly dangerous or that patients subjected to such a procedure are particularly likely to develop serious disabilities therefrom, I cannot help feeling that there is a distinct danger in returning the contaminated mucosa which occurs between the ligature on the stump of the appendix and the severed end of the stump into the free peritoneal cavity, and this even though pains be taken to treat this mucosa either with a chemical antiseptic or with heat. I furthermore believe that the procedure which involves preliminary ligation of the stump of the appendix and subsequent inversion of this ligated stump through a purse-string suture in the wall of the cecum is also not in accordance with the best surgical principles, for it involves burying a contaminated area in such a way that no outlet is provided for any secretion which may form during the process of sloughing and absorption of the strangulated tissues distal to the ligature used on the stump (Fig. 5A). I have observed that in a certain number of patients in whom the technique under discussion has been used, the postoperative condition of the patient

presented a rather typical sequence. For the first twelve, eighteen, or twenty-four hours the postoperative convalescence is no more eventful than it should be, but at the end of this period the pulse becomes somewhat more rapid, the temperature rises, sometimes only a degree or two, sometimes to 103° or even 103.5°F. The patient usually looks sick, may complain of moderate nausea, develops some abdominal pain which is usually interpreted as "gas pains," and the general condition of the patient may be so unsatisfactory as to cause the medical attendant some anxiety with respect to the cause of the condition. More or less abruptly, however, at the end of about fifty-six or seventy-two hours the patient exhibits a rather abrupt change for the better, the pulse rate decreases, the temperature diminishes, the abdominal pain ceases, and from that time on the patient makes an uneventful recovery. The obvious interpretation of this phenomenon is that septic material has been imprisoned in the wall of the cecum, has undergone a marked increase of virulence with the production of a small abscess, the abscess increasing in size until eventually the suture originally tied at the base of the appendix undergoes solution and the abscess breaks spontaneously into the cecum.

The rational method of treating the stump would then appear to be a procedure which involves inversion of the stump in the absence of preliminary ligation. The objection to such a procedure consists, of course, in the fact that usually or, at least, not infrequently a small intramural vessel occurs in the wall of the stump of the appendix which if not ligated is apt to cause a reactionary hemorrhage into the cecum. Such a circumstance can, however, be readily obviated by the simple expedient of encircling the area in which this vessel occurs with a suture. Such a suture can be conveniently placed concomitantly with the introduction of the purse-string suture by the insertion of a simple back-stitch in the location

of the mesenteric attachment of the appendiceal stump (Fig. 5B). The recommended procedure is, therefore, preliminary insertion of a purse-string suture with a back-stitch in the position previously mentioned, crushing of the base of the appendix with a strong Ochsner clamp, severance of the appendix, preferably with the actual cautery, and inversion of the crushed stump of the appendix through the purse-string suture without preliminary ligation.

In extremely difficult cases it is occasionally desirable to extend the incision in order to provide a wider exposure. This can readily be accomplished by dividing the tissues laterally, respecting the general direction of the fibers of the internal oblique and transversus abdominis muscles and carrying the incision as far as may seem necessary above the anterior spine of the ilium toward the right flank. Such an extension of the incision is rarely necessary but the amount of additional exposure which can be gained thereby is considerable and this consideration provides assurance that unusual abnormalities can almost invariably be met with confidence.

Closure of the abdominal incision is performed in four layers. The first layer includes the peritoneum and transversalis fascia. It is my custom to begin the suture at the medial angle of the wound and to sew progressively toward the lateral angle. When introducing the first stitch at the medial angle of the wound, it is important to bear in mind the anatomical position of the deep epigastric vessels in order that these may not be inadvertently damaged by the passage of the needle. In most cases the transversalis fascia in this area constitutes a rather definite layer. I am convinced that the cause of many postoperative herniations is failure to identify and accurately to suture the transversalis fascia, and accordingly during the insertion of the first line of sutures this structure is diligently sought and carefully sutured.

The transversalis fascia is, of course, quite different from the transversus abdominis muscle although the two structures are in close physical juxtaposition and are, in fact, not infrequently confused in the minds of those whose knowledge of anatomy has not been refreshed by specific reference to the matter. The transversalis fascia is a definite sheet of fascia which is spread over, but attached only loosely to the deep surface of the transversus muscle. Occasionally this structure is rather thin and indefinite, especially in certain portions of its extent; in other cases and in other portions it is an exceedingly tough and fibrous membrane which is capable of withstanding a very considerable portion of the total intra-abdominal pressure. The attachments of this structure are: *superiorly*, the fascia which covers the lower surface of the diaphragm; *posteriorly*, it becomes thinner and thinner and eventually becomes lost in the fat which covers the posterior aspect of the kidneys; *inferiorly*, from before backward it is attached (1) to the entire length of the iliac crest between the attachments of the transversus and iliacus muscles, (2) to the posterior margin of the inguinal ligament, at which point it becomes continuous with the iliac fascia, and (3) to the pubis and pectineal line; *medially*, it blends with its corresponding portion on the opposite side. Because of its usual firmness and density this structure ordinarily accounts for a very considerable part of the entire tensile strength of the anterior abdominal wall.

As soon as the first layer of sutures has been placed the rectus muscle is allowed to assume its natural position overlapping the medial half of the incision, and attention is directed to the placing of the fascial layer sutures. In placing these sutures it is my custom to begin at the medial angle of the incision and to sew toward the lateral angle. On reaching the linea semilunaris care is taken to place one stitch accurately in the linea semilunaris, and beyond this stitch the

edges of both internal oblique and transversus abdominis muscles are picked up together in the bite of the needle. The third layer closes the external oblique aponeurosis. The fourth layer of sutures closes the skin.

For some time it has been my practice to close the skin by means of interrupted sutures. I generally use paraffinized silk for this purpose, and the suture which I prefer is one which is designed to obliterate the subcutaneous dead space formed by retraction of the subcutaneous fat. If this dead space be not obliterated by one means or another, serum and blood tend to accumulate just beneath the skin, and there results a pool of liquid material or coagulated blood which does not undergo prompt absorption. The presence of such a collection of tissue fluid may be recognized by the alert surgeon who suspects its presence because of a rise in temperature and pulse rate of the patient and tenderness over the incision, and it may then be evacuated, usually after the removal of one or more stitches, or the condition goes on unrecognized until the stitches are removed after the lapse of a certain number of days at which time the margins of the wound separate, the material is extruded, and the skin incision must thereafter heal by secondary intention. This material may undergo secondary infection in which case a subcutaneous or stitch abscess forms. When introducing the suture under discussion, the purpose of which is to obliterate the dead space and accordingly to prevent the development of this complication in the wound, it is my custom to pass the suture by means of a straight Keith needle, introducing the needle when passing across the wound for the first time as near the skin edge as possible, thereafter lifting the tissues of the anterior abdominal wall perpendicularly, using the suture as a tractor, and passing the needle back through the tissues at a much deeper level (Fig. 5c).

When the transverse incision is properly made it is, I believe, the most rational

and satisfactory incision which can be used in the procedure of simple appendectomy. It is essentially a muscle-splitting, or rather a fascia-splitting, incision and in this respect somewhat resembles the McBurney incision. It possesses, however, the following very important advantages over the McBurney incision: (1) It definitely avoids injury to the ilio-inguinal and iliohypogastric nerves which emerge just medial to the anterior superior spine of the ilium. These nerves can fairly easily be injured during the dissection incident to a McBurney muscle splitting incision, especially if the incision is made too near the anterior superior spine of the ilium. They could be injured in a transverse incision only in case the operator extends the incision too far laterally and forgets the location of these important structures. (2) The transverse incision gives much better exposure than the gridiron incision length for length. (3) The exposure being better in the transverse incision, the transversalis fascia is more readily located and sutured during closure. (4) Postoperative hernias do not seem to occur with any degree of frequency in connection with the transverse incision, but for some reason not altogether clear are frequent in connection with the gridiron incision.

STATISTICAL SURVEY OF CLINICAL DATA

As stated in the title of this communication, the statistical survey of cases is based upon 100 consecutive appendectomies. These were performed by the technique already described, between February, 1928 and June, 1931.

The first portion of the survey concerns itself with the more important clinical facts which were established during the course of the patient's actual residence in the hospital and include: (1) the age incidence of the disease "chronic appendicitis" as it has been my privilege to observe it in a ward for white female patients; (2) the clinical manifestations of the disease both with respect to duration

of symptoms at the time the patient came under observation and the identity and general distribution of those symptoms among the group of cases; (3) the laboratory data obtained from the cases, especially the details of the urinalysis and blood picture; (4) the serological (Wassermann) reaction with respect to syphilis; (5) the operative findings as gleaned from the notes dictated immediately after the operation to the operating-room staff secretary of the hospital; (6) the nurses' record of the temperature of the patients on the day preceding operation and for five consecutive days thereafter, and (7) my own, the interne's, or some other member of the staff's note at the time of the removal of sutures as to the condition of the operative incision at that time.

The second portion of the survey concerns itself with data obtained partly from a questionnaire sent to patients some time after their dismissal from the hospital and partly from personal observation of patients who on request but voluntarily presented themselves to me for examination of end results.

AGE INCIDENCE: The ages of the patients ranged between twelve and forty years, the average age for the entire group being 17.9 years. The distribution was as follows:

Between 12 and 15 years.....	28 per cent
Between 16 and 20 years.....	56 per cent
Between 21 and 25 years.....	11 per cent
Over 25 years.....	5 per cent

DURATION OF SYMPTOMS: The duration of symptoms at the time of application of the patient to the hospital for treatment ranged from three days to eight years, the average duration was 16.5 months. The distribution was as follows:

Less than 1 month.....	8 per cent
Between 1 month and 3 months.	16 per cent
Between 4 months and 12 months	41 per cent
Between 1 year and 2 years.....	17 per cent
More than 2 years.....	18 per cent

"ATTACKS OF APPENDICITIS": Seventy-one per cent of the patients had experienced one or more definite "attacks of appendicitis"; in the remaining 29 per

cent the complaints were of a more insidious onset without acute exacerbations.

Time Interval since Last Attack: In the case of those patients who gave a history of attacks, the average time interval which had elapsed between the onset of the last attack and the date of the operation was 17.3 days; the shortest interval of time was three days and the longest was eighty-five days. These figures are of no particular interest except as they serve to emphasize the fact that the type of appendicitis under discussion is not the acute or subacute variety but so-called "chronic appendicitis."

SYMPTOMS: *Pain:* All patients complained of pain. The site of the pain was located in most of the cases in the right lower quadrant of the abdomen. In more than half such cases the pain was said to show no radiation. When the pain showed radiation the most frequent direction was toward the right thigh and leg. In the remaining cases the radiation was either through to the back or both to the back and to the right thigh.

Site of the pain in the right lower quadrant of the abdomen.....	83 per cent
No radiation of the pain.....	56 per cent
Radiation of the pain to right thigh or right thigh and leg...	21 per cent
Radiation to right side of the back and region of the right kidney.	4 per cent
Radiation both to the back and to the right thigh.....	2 per cent
Total.....	83 per cent

Site and radiation of pain in the remaining cases was as follows:

Region of the umbilicus radiating to the right lower quadrant of the abdomen.....	10 per cent
Both lower quadrants of the abdomen without radiation.....	5 per cent
General abdominal pain.....	2 per cent
Total.....	17 per cent

Nausea: Nausea was a feature of the disease in considerably more than half the cases. In only a small percentage, however, was it severe.

Severe nausea.....	10 per cent
Moderate nausea.....	51 per cent
No nausea.....	39 per cent

Vomiting: Vomiting was a feature of the disease in slightly more than one-third of the cases, but severe or repeated vomiting was only occasionally reported.

Severe or repeated vomiting.....	8 per cent
Occasional vomiting.....	27 per cent
No vomiting.....	65 per cent

Constipation: Constipation was far from the rule, and severe constipation was a relatively rare symptom.

Severe constipation.....	5 per cent
Moderate constipation.....	13 per cent
No constipation.....	81 per cent
(Alternating constipation and diarrhea—1 per cent)	

Other Symptoms: Because of the fact that the data from which these statistics were compiled consisted of routine hospital histories it would be misleading to attempt any exact statistical record of minor symptoms inasmuch as undoubtedly specific questions with regard to the entire list of minor symptoms were not attempted in recording the anamnesis. It is interesting to note, however, that (1) stiffness of the right thigh and (2) headache were each mentioned as prominent symptoms in more than 10 per cent of the cases. Dizziness, weakness, distention and belching, fainting, frequency of urination and burning on urination, weakness and loss of weight, and anorexia were prominent symptoms each in more than one case.

TEMPERATURE ON ADMISSION TO HOSPITAL: The mean temperature *per os* of the group on admission to the hospital was 98.5°F.

LEUCOCYTE COUNT: The mean leucocyte count is recorded in the following tabular form:

Total Leucocytes	Polymorphonuclear Leucocytes, Per Cent	Large Mononuclear Leucocytes, Per Cent	Lymphocytes, Per Cent
5325	71.02	3.11	24.7

Only 19 of the cases presented a total leucocyte count of 10,000 or more. A more detailed resume is as follows:

Less than 6000 leucocytes.....	3 per cent
Between 6000 leucocytes and 7000 leucocytes.....	20 per cent
Between 7000 leucocytes and 8000 leucocytes.....	14 per cent
Between 8000 leucocytes and 9000 leucocytes.....	30 per cent
Between 9000 leucocytes and 10,000 leucocytes.....	14 per cent

URINE: The routine urinalysis showed no positive findings worthy of note in 40 per cent of the cases. In the remaining cases the findings were reported as follows:

Occasional pus and epithelial cells	25 per cent
Occasional pus cells.....	15 per cent
Occasional epithelial cells.....	6 per cent

The remaining 14 cases presented:

Many pus cells.....	2 cases
Many pus and epithelial cells, occasional casts.....	2 cases
Occasional pus cells and hyaline casts	2 cases
Occasional red cells.....	2 cases
Many epithelial cells.....	2 cases
Occasional pus cells, many bacteria...	1 case
Occasional cylindroids, few pus cells...	1 case
Albumen and casts.....	1 case
Trace of sugar.....	1 case

No examinations were made for acetic acid and acetone or for indican.

WASSERMANN REACTION: The Wassermann reaction was negative in all cases in the series.

ANESTHESIA: Various anesthetic agents were used in performing the operations on the patients in the group, as follows:

Avertin (basal anesthesia).....	27 cases
Local anesthesia (procaine).....	2 cases
Ethylene.....	2 cases
Nitrous oxide.....	2 cases
Sacral analgesia.....	1 case
Ether.....	66 cases

In 4 of the 27 cases in which avertin basal anesthesia was used this anesthetic did not need reinforcement, and the operation was accordingly performed under avertin anesthesia alone. In the remaining 23 cases the avertin was reinforced with a small amount of ether, usually less than 1½ ounces of the latter being sufficient. Undoubtedly ether might not have been

required in certain of the cases in which it was actually used, but it became apparent after some experience with avertin had been gained that in the dose used (100 mg. per kilogram of body weight) some of the patients would tolerate the making of the initial incision without any reaction of any kind, but became unruly when hemostats began to be applied. This was disconcerting because manipulations then had to be suspended until a small amount of ether could be given; accordingly, it soon became routine practice to give a small amount of ether before the incision was made whether it seemed likely that the basal anesthetic would suffice or not.

Local anesthesia was adopted in 2 cases because of respiratory tract infection of patients.

Sacral analgesia was adopted in 1 case as a demonstration that extradural anesthesia can be used on occasion for the performance of abdominal operations. It is not believed, however, that such anesthesia is either desirable or entirely safe for such purposes; I do not make a practice of resorting to this method, and I do not recommend that others do so.

In avertin, on the other hand, I believe has been found an almost ideal form of basal anesthesia, and I feel that the extra time taken in giving this form of anesthesia pays rather rich dividends both in comfort to the patient and in satisfaction to the surgeon, especially as concerns the early postoperative period.

It will be noted that spinal anesthesia was not used at all in this series of cases. Although I fully appreciate the advantages of spinal anesthesia as far as the operator is concerned and the advantages to the patient in the vast majority of cases, especially as concerns the early postoperative period, I am not quite convinced that the margin of safety either as regards life or the development of postoperative sequelae is quite as great in appendectomy cases as a general anesthetic offers. Fortunately I have had no unpleasant experi-

ences myself with spinal anesthesia and I do not hesitate to use it when it seems to offer decided advantages over a general anesthetic, but I have had occasion to observe some of the undesirable post-operative sequelae of spinal anesthesia in an outpatient clinic to which are referred cases previously operated upon by other surgeons: persistent headache, backache, residual paralyses, sequelae of which the particular operator himself is almost necessarily profoundly unaware, and for this reason I have become a trifle apprehensive and cautious.

OPERATIVE FINDINGS: The operative findings herewith recorded are taken from notes dictated at the time of operation. Because of the fact that in certain cases there were several associated abnormalities the classification about to be introduced is not altogether satisfactory, but inasmuch as any classification must of necessity ignore certain particular features of certain individual cases, in order to group the cases at all, the result must be a compromise. The particular abnormalities noted were distributed as follows:

Fibrous adhesions and associated angulations of the appendix.....	27 per cent
Fibrosis of the wall of the appendix with definite imprisonment of fecaliths.....	12 per cent
Unusual shortness of the meso-appendix and associated acute angulation of the appendix.....	10 per cent
Unusual fibrosis of the wall of the appendix in the absence of fecaliths.....	10 per cent
Funnel shaped appendix.....	10 per cent
Appendix showing definite evidences of subsiding acute inflammation.....	9 per cent
Fibrosis of the wall of the appendix with clubbing at the end of the organ.....	7 per cent
Appendix retrocecal and retroperitoneal...	7 per cent
McKinley's bands.....	5 per cent
Fibrosis of the appendix causing definite circular constrictions.....	3 per cent

Associated or additional abnormalities included:

Noteworthy simple cysts of the right ovary	12 per cent
Noteworthy simple cysts of the left ovary.	2 per cent
Meckel's diverticuli (not apparently inflamed or causing symptoms).....	2 per cent

WOUND REPAIR: In the entire series 92 per cent of the wounds underwent healing by primary intention, and by primary

intention is meant complete absence of secretion from the wound after about twelve hours and ultimate fine linear scar formation. Those wounds which required probing in order to evacuate small hematomas or seromas were considered as having undergone healing by second intention regardless of the ultimate appearance of the scar; of these there were 6 per cent. In 2 per cent of the cases the appendectomy wound became infected.

POSTOPERATIVE FEVER: The temperature charts of the cases have been summarized in two different ways. First the highest and lowest temperatures for each patient for each separate day were averaged and then the mean daily temperature of all the patients for that day was computed. Second the means of the highest and also of the lowest recorded temperatures for each successive day were computed. Temperatures were used for the day immediately preceding the operation and for five successive days thereafter. The postoperative fever reached its highest point within twenty-four hours following the operation and the temperature progressively and constantly decreased to its preoperative level on the fifth postoperative day.

STATISTICAL SURVEY OF QUESTIONNAIRE AND PERSONAL EXAMINATION OF PATIENTS

On May 1, 1931, the following questionnaire was sent to all patients in the series who had been operated upon prior to this date. It will be noted that only 90 of the 100 cases were thus solicited. In the other 10 cases the operative date had been so recent that it was most unlikely that the patient's condition would have changed sufficiently since discharge from the hospital to make replies of any particular value.

1. Have you been relieved of your symptoms: Pain, nausea, and vomiting?

2. If you still have the same kind of symptoms you had before your operation did your operation relieve them temporarily? If so, for how long?

3. Is the scar of your operation painful?

4. Is the scar any wider than when you left the hospital? If so, how much?

5. Does your abdomen protrude in the region of the scar?

6. Do you suffer from constipation or diarrhea?

7. Have you borne any children or have you been pregnant since your operation?

8. Do you suffer from indigestion?

9. Are you satisfied with the result of your operation?

10. What does your Doctor think of the result of your operation?

11. What kind of work have you been doing since your operation?

Of the questionnaires dispatched 25 were returned as unclaimed, the postal authorities being unable to deliver the communication to the person addressed. Six were apparently delivered but were not answered, and 59 replies were received. Seven of the 59 patients presented themselves in my office for personal examination. In the remaining 52 cases results were compiled from the written statements of the patients alone.

RELIEF OF SYMPTOMS: Forty-two, or 71.2 per cent, of the patients who replied to the questionnaire reported that they had been completely and permanently relieved of symptoms and considered themselves well. The remaining 17 or 8.8 per cent of the patients reported incomplete relief of symptoms or no relief at all. The more significant statements culled from the replies are as follows:

1. "Relief for several months, but worse now"; this patient, however, has been pregnant for the past four and a half months and had been completely relieved of symptoms between the time of operation and the time of becoming pregnant.

2. Has "vomiting pains when the weather changes"; this patient has been pregnant for five months.

3. "Relief for a period after my operation but not long"; this patient has been pregnant for four and a half months.

4. "Relief for about three weeks"; this patient was personally examined by me.

She has been under hospital treatment for pyelitis and pelvic inflammatory disease since operation and has been pregnant for two and a half months.

5. "Relief for about three weeks."
6. "Was relieved for two months."
7. "Was relieved for three months, but symptoms have returned."
8. "Relief for about three months but now under doctor's care for the same thing."
9. "Was relieved for eleven months but now pain has returned."
10. "Was relieved for about a year."
11. Completely relieved for a year and a half but now "suffers from nausea."
12. Still suffers "from pain in the right side, nausea, and vomiting."
13. Suffers from "weak nerves and blind spells."
14. Has "pains in the right side" and gets "sick at the stomach."
15. Symptoms recur "during menstruation."
16. Has "pain only during menstruation."
17. "Well except for occasional attacks of nausea."

Without attempting in any way to minimize the fact that a considerable number of patients were not relieved of their symptoms, the foregoing statements and comments seem to indicate that the percentage of patients permanently relieved of their symptoms by the operation is at least not overstated by the figure given (71.2 per cent).

PAIN IN SCAR: The operative scar was reported as being not painful by 43 patients, or 72.9 per cent, of cases. The remaining 16 cases, or 27.1 per cent, reported as follows:

1. "Scar is painful only since I have been pregnant."
2. "Scar is painful since I am pregnant."
3. "Scar was painful during pregnancy but not otherwise."
4. Occasionally has a "sharp pain in the scar which lasts for a few minutes."
5. "Scar is painful at times."

6. "Scar is painful" (5 cases); two of these cases have keloid formation in the scar according to their doctors.

7. "Scar is very painful."
8. "Scar is occasionally painful in cold weather."
9. "Half the scar is painful."
10. "Scar is tender but not painful."
11. "Scar is not painful, but sometimes there is a pinching sensation in it."
12. "Once the scar burned so badly I fainted."

WIDTH OF SCAR: The scar was reported as being no wider than it was at the time of the patient's discharge from the hospital in 42 cases, or 71.2 per cent. The remaining 17 cases, or 28.8 per cent, reported as follows:

1. "Scar a little wider" (2 cases).
2. "Scar very little wider."
3. "Scar a least bit wider."
4. "Scar wider but not very much."
5. "Scar a little wider but so little you can hardly notice it."
6. Other cases estimated the width as $\frac{1}{16}$ inch (1 case), $\frac{1}{8}$ inch (2 cases), $\frac{3}{16}$ inch (2 cases), $\frac{1}{4}$ inch (1 case), and $\frac{1}{2}$ inch (3 cases).
7. In two cases keloid formation in the scar was reported by the patients' doctors.

PROTRUSION OF ABDOMEN IN REGION OF SCAR: In 53 cases, or 89 per cent, patients reported no protrusion of the abdomen in the region of the scar. The remaining 6 cases or 10.1 per cent reported as follows:

1. Three patients simply stated that the abdomen did protrude in the region of the scar, but two of these are said by their doctors to be suffering from keloid formation.
2. "Abdomen protrudes a very little in one place."
3. "Abdomen protrudes a little."
4. "Abdomen protrudes a little."

CONSTIPATION AND DIARRHEA: Of the 59 patients 42, or 71.2 per cent, reported that they suffer from neither constipation nor diarrhea. The remaining 17 patients, or 28.8 per cent, state that they suffer from

constipation but not from diarrhea. In one case previously existing constipation was relieved by the operation; in another case, constipation has been a symptom only since operation.

PREGNANCIES: Five of the patients report that they are pregnant at present. Of these, three are having untoward abdominal symptoms and two have no such symptoms. Two patients were pregnant at the time of operation and delivered uneventfully (one gave birth to twins). Five have become pregnant and have given birth to children since their operation. Their deliveries were uneventful; one reports also an intermediate miscarriage.

INDIGESTION: Thirteen patients or 22 per cent report that they suffer from indigestion. In most cases, it is stated that the indigestion occurs only on rare occasions and is not attributed to the effects of the operation. In the other cases, the indigestion is associated with pregnancy or with a preexisting condition which the operation failed to relieve. In no case was the indigestion of postoperative origin unless associated with pregnancy.

PATIENT'S ESTIMATION OF SUCCESS OF OPERATION: Fifty-one patients, or 85.6 per cent, expressed complete satisfaction with the results of the operation. The comments of the eight patients, or 14.4 per cent, who expressed dissatisfaction are abstracted:

1. "Was satisfied until I became pregnant" (2 cases).
2. "I am not well at all."
3. "I am under another doctor's care."
4. "I am not quite satisfied."
5. "No" (2 cases).

FAMILY PHYSICIAN'S ESTIMATION OF SUCCESS OF OPERATION: Only 40 of the 59 patients had been examined by private physicians since their operations. Of those who had consulted their own physicians, 35 patients, or 87.5 per cent, stated that the physician who examined them was completely satisfied with the result. A resume of the unfavorable replies follows:

1. "Doctor said something was done wrong at operation." This patient at the time had been under treatment for pyelitis

and acute pelvic inflammatory disease.

2. "Doctor said it was a bad scar"; the patient herself says, however, that she has been completely relieved of symptoms, has borne a child and is entirely satisfied with the result of the operation.

3. "Doctor says the result is good except for keloid."

4. "Doctor says I'll never be relieved of pain."

5. "Doctor says it's the first time he ever saw an operation that way" (scar transverse).

PATIENTS' ACTIVITIES SINCE OPERATION: Almost all of the patients state that their activities include housework, but many have other duties besides: such as, "cutting sugar cane," "packing berries," "working in a restaurant," "working as clerk in a store," "farmwork," "chopping cotton," "working in a salt factory," "hoeing in the field," "any work a woman can do." Eight patients go to school, three work only in a factory and three work only as clerks. Only three patients have no stated duties.

DISCUSSION AND CONCLUSIONS

It is not maintained and it should not be considered as implied that this survey makes a case for the superiority of the transverse incision. In fact, were the series of operations many times as extensive and the analysis far more exhaustive, the way would still be open for many differences of opinion. Certainly the percentage of satisfactory results obtained in any series of operative cases is not necessarily a safe criterion of the excellence of operative technique for many reasons, a very obvious one being that unless the procedure which is used is adapted to the actual abnormality responsible for the patient's symptoms, it cannot succeed; accordingly the problem of relief of symptoms is fundamentally a matter of correctness of diagnosis. All that is claimed for the present survey is that it is believed to demonstrate the general feasibility of the technique suggested and the relative freedom of the procedure itself from undesirable complications and sequelae.

The series of statistics which have been

recorded has been collected with the utmost sincerity and no attempt has been made to conceal the less complimentary side of the picture. I believe it is of some significance that although only 71.2 per cent of the cases stated that they had been completely relieved of symptoms, 85.6 per cent expressed themselves as entirely satisfied with the results of the operation. Although certain of the patients stated that the abdomen protrudes slightly in the region of the operative scar, I believe none of these protrusions represents postoperative herniation; I personally examined three of these patients and the protrusion was extremely slight; at all events I have never seen a case of postoperative herniation through a transverse appendectomy incision. Although the width of abdominal scars and their general unsightliness is perhaps a minor matter in comparison with functional excellence, there can be little question but that the transverse scar shows less tendency to widen and become increasingly apparent with the passage of time than any other.

Finally, I have been keenly interested in attempting to analyze the causes of failure in those cases in which the end result of operation was unsatisfactory. Apart, however, from the rather superficial observation that in some cases dissatisfaction arose only during a subsequent pregnancy, the result of this analysis has yielded little of especial interest. As far as those cases which I have not been able to examine personally are concerned, careful perusal of the case histories gives little clue to the causes of failure; this is illustrated by the following three condensed case histories:

CASE I. R. D., operated upon June 17, 1930. Age sixteen years. Duration of symptoms: twelve months. Last attack: seventeen days ago. Chief complaint: Pain in the epigastrium radiating to the right lower quadrant of the abdomen. No nausea but has vomited several times. No constipation. No other complaints. Leucocyte count 10,000, with 72 per cent polymorphonuclear leucocytes. Urinalysis negative. At operation about 100 c.c. of clear straw-colored fluid welled up into the wound. Definite Jackson's veil. Cystic left ovary. Postoperative temperature at its highest on

the third day, 100.4°F. Temperature normal on fourth day. Wound healing by primary intention.

CASE II. S. C., operated upon July 8, 1930. Age twenty years. Duration of symptoms: thirteen months. Last attack: six days ago. Pain in both lower quadrants of the abdomen radiating to the back, no nausea, no vomiting, severe constipation. Also complaints of dizziness and frequency of urination. Leucocyte count: 9800, 64 per cent polymorphonuclear leucocytes. Urinalysis negative. Upon opening the abdomen, considerable clear, yellow, straw-colored fluid. Many adhesions about the appendix. The organ was both retrocecal and retroperitoneal and was acutely angulated in its midportion. Small hematoma evacuated from the wound on the third postoperative day. Postoperative fever at its height on the fourth postoperative day, 100.2°F. Normal on fifth postoperative day.

CASE III. L. N., operated upon March 1, 1930. Age sixteen years. Duration of symptoms: eight years. Last attack ten days ago. Pain in the right lower quadrant of the abdomen. Considerable nausea and vomiting, suffered severely from constipation. Patient faints occasionally. At one time, feces were positive for hookworm but treatment for hookworm has failed to relieve the symptoms. Leucocyte count 10,500, 72 per cent polymorphonuclear leucocytes. Urinalysis revealed few epithelial cells, occasional pus and red blood cells. Appendix long, of small caliber, with definitely fibrotic walls and retrocecal. Postoperative fever at its height on the fourth postoperative day, 99.6°F., normal on fifth. Operative wound healed by primary intention.

In the three cases of unsatisfactory end result which I have had occasion to examine, the findings were as follows:

CASE I. Patient subsequently under treatment in the hospital for right-sided pyelitis; recently married and has contracted gonorrheal endocervicitis and bilateral salpingitis.

CASE II. Patient sixteen years old, very much overweight and apparently suffering from a lipo-dystrophy.

CASE III. Patient is suffering from pulmonary phthisis as shown by skiagrams; sputum positive for acid-fast bacilli.

In short, in no case has the operative procedure itself seemed to have been responsible for untoward results except possibly in association with the formation of postoperative intra-abdominal adhesions.

CHRONIC CYSTIC ARACHNOIDITIS*

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THE symptoms of lesions of the brain produced by tumor, abscess, aneurysm, and localized areas of

one confined to the arachnoid, and is evidently a residue from a previous attack of meningoencephalitis.

These inflammatory lesions may involve the cerebral hemispheres, and produce Jacksonian convulsions or paresis of one or both extremities on the opposite side. They may involve the optic chiasm and produce decreased visual acuity or defects in the visual fields, or they may involve the posterior fossa and produce intracranial hypertension and symptoms of cerebellar involvement.

In some of the cases, there may be a history of previous nasopharyngeal or pulmonary infection suggesting an inflammatory lesion, but the development of symptoms is frequently so similar to that of a fairly rapidly growing tumor of the brain that no preoperative indication of the underlying pathologic change is obvious. Regardless of the pathologic etiology, operation is the only satisfactory method of treating increased intracranial pressure, as well as localized lesions of the brain which are not degenerating.

Chronic arachnoiditis occurring in the posterior fossa so interferes with the escape of cerebrospinal fluid that increased intracranial pressure, internal hydrocephalus, and the resulting papilledema, or choked disk, with failing vision may necessitate early surgical intervention to prevent permanent injury to vision due to secondary optic atrophy.

Horrax¹ has called attention to the fact that apparent arachnoiditis may be associated with a tumor in the posterior fossa, but before a definite diagnosis can be made, a careful search should be instituted at

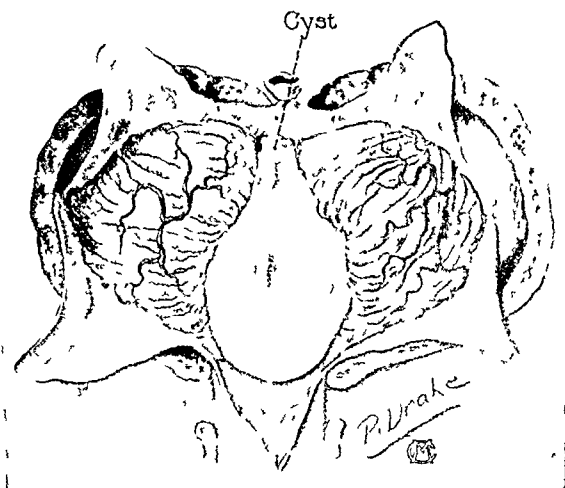


FIG. 1. Case 1. Inflammatory cyst completely blocking fourth ventricle.

inflammation have been designated the "brain tumor syndrome" because neoplasms predominate as the causative factor. The significant clinical features of the syndrome are headache, vomiting, and choked disks associated with failing vision, and any one, or a combination of these, may suggest a diagnosis of tumor of the brain.

Probably the smallest and most interesting group of cases in which this syndrome is a background for its symptoms is that of inflammatory lesions of the brain and meninges. The entire clinical course from onset to operation is that of an indeterminate lesion of the brain so closely simulating the history and development of a tumor of the brain that a differential diagnosis is very difficult and is usually made at the time of operation. The lesion is usually an inflammatory

¹HORRAX, G. Generalized cisternal arachnoiditis simulating cerebellar tumor: its surgical treatment and end-results. *Arch. Surg.*, 9: 95-112, (July) 1924.

* Submitted for publication June 10, 1932.

the time of operation for any associated neoplasm. The ultimate test, however, depends on the subsequent history of

experienced a sudden, severe headache over the frontal region, extending into the occipital region and radiating down the neck. After a

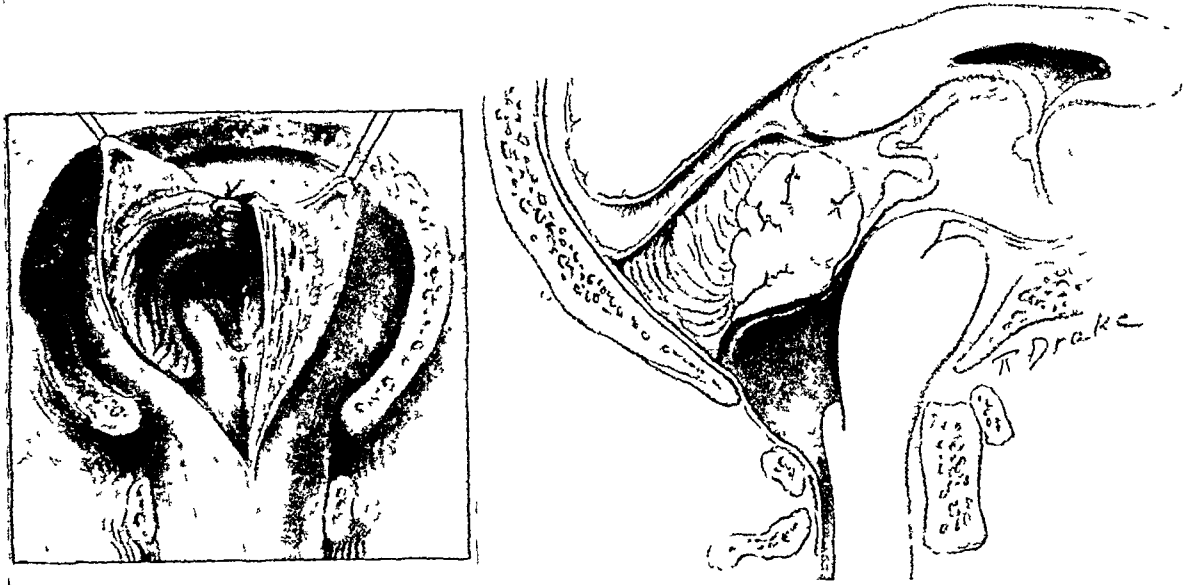


FIG. 2. Case II. Arachnoiditis producing internal hydrocephalus and simulating tumor of posterior fossa.

relief. Arachnoiditis of the cisterna cerebromedullaris probably responds better to surgical treatment than any other inflammatory cerebral lesion because by relieving intracranial hypertension and reestablishing the flow of cerebrospinal fluid, the symptoms immediately disappear and the papilledema recedes, preventing or arresting any tendency toward secondary atrophy of the optic nerve and loss of vision.

In order to illustrate the difficulties encountered in the diagnosis of these lesions and to present the clinical results following operation, as well as to emphasize the necessity of early operation, three cases of cisternal arachnoiditis are being used for comparison and contrast.

REPORT OF CASES

CASE I. A woman, aged twenty-three years, came to The Mayo Clinic complaining of headaches, failing vision and ataxia. She had apparently been in excellent health until one and a half years previous to registration, when she first noted blurred vision of the left eye. She had had no further symptoms until nine months prior to examination when she

few days, the headaches subsided until seven months before registration when they began to occur at weekly intervals. The headaches came on suddenly at 4 or 5 A.M. and lasted from one to twelve hours. They were described as "bursting," and were so severe that she was forced to remain in bed. They gradually grew more severe and frequent and were accompanied by double vision, projectile vomiting, and buzzing in the ears; about this time, she also noted sudden attacks of vertigo on changing position. For the previous three months, she had been unable to read because of marked failure of vision of both eyes. She had also noted progressive awkwardness of the left foot and left hand, associated with a marked feeling of lassitude.

Examination revealed that the patient was apparently in good physical condition with little loss of weight; she was unable to see very well and walked with a staggering gait. Urinalysis, blood count, and Wassermann reaction of the blood gave negative results. A roentgenogram of the head was negative, but one of the thorax revealed healed tuberculosis of the apex of the lobe of the right lung. The vision of the left eye was reduced to counting fingers, and that of the right eye to moving objects. The fundi revealed the presence of bilateral choked disks of 7 diopters in the right

eye and 6 diopters in the left eye, with hemorrhages and exudates and commencing pallor. Neurologic examination was essentially nega-

improved and she could get about and do housework, but could not do close needlework or read fine print.

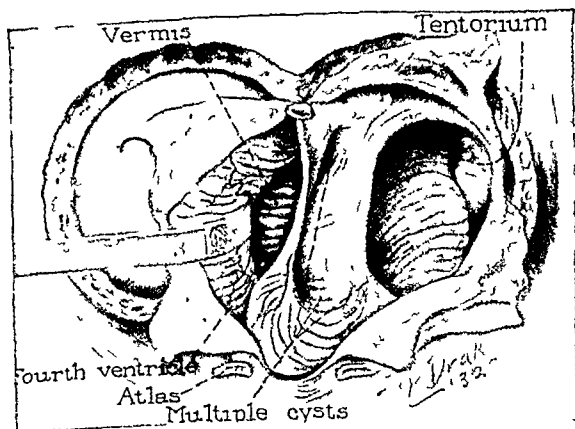


FIG. 3. Case III. Multiple inflammatory cysts of posterior fossa associated with inflammatory condition of lungs.

tive except for slight ataxia and incoördination. Because of the extreme intracranial pressure, and the paucity of localizing signs, ventriculography was advised.

The lateral and third ventricles were found to be dilated, which indicated obstruction in the ventricular system, probably in the posterior fossa, and a suboccipital exploration was carried out through a cross-bow incision. On incising the dura, a large inflammatory cyst, 5 cm. in diameter, was found lying in the fourth ventricle and posterior cistern, associated with chronic cystic arachnoiditis (Fig. 1). The arachnoid could be incised, and the cyst was found to be inclosed in a membrane resembling the arachnoid. The cyst was aspirated and its walls were completely removed from the fourth ventricle. Following this, the cerebrospinal fluid, colored by the indigocarmine, could be seen escaping into the fourth ventricle.

After an uneventful convalescence, the patient was allowed to return home. The papilledema had receded to 2 diopters in each eye at the time of dismissal, and her general condition was excellent.

The condition of the patient was followed with a great deal of interest, because of the beginning atrophy of the optic nerve, and the extremely high papilledema. A letter three years after operation reported that she was in excellent physical condition; her vision, although still not perfect, was definitely

There was nothing in the early history in this case to indicate the presence of an inflammatory lesion, and the method of onset so simulated a tumor in the posterior fossa that it required exploration to determine the cause of the disability. Comment on the treatment of this case would consist of criticism of the delay of operation, since the atrophy of the optic nerve, which was present at the time of the operation, prevented the vision from returning to normal. This case illustrates the need for early diagnosis of intracranial lesions and immediate operation.

CASE II. A girl, aged eighteen years, registered at the clinic because of headaches, nausea and vomiting. She had been perfectly well until one year previously when she had had a sudden attack of severe headache. The pain was described as dull, pressing and tight, and confined to the frontal region, becoming progressively worse and associated with nausea and projectile vomiting. The attack lasted twelve days, following which she was extremely dizzy when she sat up; she also complained of tinnitus in both ears, blurred vision and diplopia. A spinal puncture at this time revealed increased pressure of the cerebrospinal fluid; there was complete relief of all symptoms following spinal drainage. She was free of symptoms until a second attack occurred, ten months later, which was similar to the first attack and was relieved by spinal puncture. However, the third attack came on two months later and had not been relieved up to the time of her admission to the clinic.

Examination revealed that the patient was apparently in good physical condition except that headaches confined her to bed. Urinalysis, blood count, and Wassermann reaction of the blood gave negative results. Roentgenograms of the head and thorax were negative. On examination of the eyes, the perimetric fields and ocular movements were normal, but the fundi revealed bilateral acute choked disks of 3 diopters, with hemorrhages and exudates. Neurologic examination was negative except for loss of abdominal reflexes and the presence of a bilateral Babinski reflex.

A diagnosis was made of unlocalized lesion of the brain with increased intracranial pressure, and ventriculography was advised. The roentgenograms showed the presence of internal hydrocephalus with a dilated third ventricle, indicating a lesion in the posterior fossa. Consequently, a suboccipital exploration was performed through a modified cross-bow incision and the dura was found markedly thickened, injected and very tense. The arachnoid was thickened and the seat of an inflammatory reaction (Fig. 2). The fourth ventricle was slightly dilated and there was no sign of tumor. In order to test the patency of the ventricular system, air was injected into the lateral ventricle and was found to bubble through into the fourth ventricle. A diagnosis was made of chronic cisternal arachnoiditis and the wound was closed.

The patient had a very stormy convalescence, but at the time of her dismissal, her condition was definitely improved. The papilledema had receded, and the headaches, nausea and vomiting had been relieved. A letter received three years after her return home reported that she had recovered completely.

This case is interesting from the standpoint of treatment, for the first attack was relieved by drainage of spinal fluid after it had been found to be under increased pressure. A second attack was relieved by the same method, but the third attack did not respond so satisfactorily and operation revealed the cause. Had this case been allowed to proceed further before instituting surgery, vision would probably have been affected much the same as in the first case, but the relief of pressure prevented the papilledema from progressing to atrophy of the optic nerve. The report of the patient's condition three years after operation confirmed the diagnosis and emphasizes again the necessity for early operation.

CASE III. A girl, aged nine years, was brought to the clinic because of headaches, projectile vomiting and blurring of vision. She had apparently been normal at birth; delivery had been instrumental and at full term. Her growth and development had been normal although her appetite had never been

good. The present illness began with a very severe cold contracted six months previous to examination. This was followed by bronchitis and persistent cough. Five months before registration, she had had intermittent and severe frontal headaches, localized over the right side of the forehead and right eye, and extending back into the occipital region. Three weeks before admission, attacks of vomiting began to occur once or twice daily, and a week later, diplopia and blurring of vision developed. She had to remain in bed for three weeks before coming to the clinic.

On examination, it was apparent that the patient was extremely sick and undernourished. The head was tilted to the right and there was a frequent hoarse cough. Urinalysis, blood count, and Wassermann reaction of the blood gave negative results. A roentgenogram showed rather marked infiltration of the left middle and lower part of the thorax. These changes suggested an abscess of the lung or possibly a primary malignant lesion. The roentgenogram of the head revealed increased intracranial pressure with separation of the sutures. Vision was found to be 6/12 in the left eye and 6/30 in the right eye. The pupils were equal and the reflexes were normal. The perimetric fields were normal. Examination of the fundi revealed bilateral choked disks of 3 to 4 diopters with hemorrhages and exudates. On moving the head, the neck was stiff and rigid. Neurologic examination revealed definite weakness of the soft palate and pharynx on the left. The reflexes in both the upper and lower extremities were greatly diminished and Babinski, Mendel-Bechterew, and Schaeffer signs were positive on both sides. The gait was markedly ataxic and there was definite incoördination of movements.

In this case of definite symptoms of increased intracranial pressure, due probably to a lesion in the posterior fossa, diagnosis was difficult. The history of coughing and the roentgen-ray evidence of a pulmonary lesion immediately suggested primary malignancy or abscess of the lung with metastasis to the brain. For that reason, bronchoscopy was done which revealed an inflammatory, non-purulent pulmonary lesion. The patient was immediately hospitalized, given daily inhalations of steam, cod liver oil, 1 per cent creosote, hypertonic solution of glucose intravenously, and enemas of magnesium sulphate. Under this treatment, the

cough improved, the vomiting stopped, and the child was able to take nourishment by mouth.

After the patient had been on medical treatment for two weeks, and a second roentgen-ray examination showed improvement in the pulmonary condition, it seemed advisable to proceed with an exploration of the posterior fossa. Because of the pulmonary complications, the patient was given pentobarbital sodium, grains $1\frac{1}{2}$, the morning of the operation, and after she was brought to the operating room, tribromethyl alcohol was given by rectum. Then, under regional anesthesia, a median line incision was made over the cervical and suboccipital region, and after the periosteum had been reflected, bilateral cerebellar exploration was performed, which exposed a very tense, fibrous reddish dura. Cerebrospinal fluid was allowed to escape from the posterior horn of the left lateral ventricle which relieved the pressure and allowed the dura to be incised. A large multilocular inflammatory cyst occupying almost two-thirds of the posterior fossa could be seen pushing the vermis and a portion of the right cerebellar lobe across the median line (Fig. 3). The tonsilla cerebelli and vermis were covered with vascular adhesions. The cyst was opened and it was possible to strip the wall from the cerebellum and the dura. The wound was closed in the usual manner and the patient was returned to her room.

Convalescence was gratifyingly uneventful; the patient was allowed out of bed on the twelfth postoperative day and went home on the seventeenth day. At the time of dismissal, the papilledema had receded to a point where it was no longer measurable. Roentgenograms of the thorax showed almost complete absence of infiltration. Six months later, a report stated that she had gained in weight, her cough had disappeared, and she was able to run and play without ataxia, dizziness, or blurring of vision.

This case is outstanding in many respects. It differs from most cases of arachnoiditis in that there was a definite history of pulmonary infection which preceded the intracranial symptoms and indicated the nature of the lesion. However, this predisposing factor added to the difficulties of diagnosis, simulating an abscess or a malignant lesion of the lung, and necessitating bronchoscopic examination before the true nature of the lesion could be determined. The medical treatment combined with the hypertonic regimen no doubt played an important part in the successful surgical result, for in intracranial operations, as well as in gastric, thyroid and other types of operation, the advantage of preoperative treatment is being learned. The type of anesthetic also contributed to the success of the operation, for had any one of the general anesthetics been tried, the pulmonary condition would probably have caused further trouble, but a combination of pentobarbital sodium given to the patient in her room to allay any excitement previous to coming to the operating room, the tribromethyl alcohol to produce relaxation, and the regional anesthetic to prevent undue stimulation during the operation, gave a splendid result.

The symptoms observed in these three cases are probably representative of most of the phases of diagnosis and of the difficulties encountered in treatment of inflammatory intracranial lesions which comprise the classification of chronic cisternal arachnoiditis.



SOME RADIOGRAPHIC ASPECTS OF URINARY CALCULI*

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THE composition of urinary calculi as reported by various investigators in different parts of the world differs some foreign body and 1.4 per cent cystine. In a series of 207 calculi investigated by the author at the Brady Foundation



FIG. 1. Plain x-ray showing no definite shadows of calculi.



FIG. 2. Pyelogram of same case showing several filling defects. Calculi found at operation.

widely. There is some difference of opinion as to whether urates or oxalates are the more frequently found constituents of stones in the urinary tract. It is maintained by many that calcium oxalate is the most predominant of all types of calculi and that uric acid, urates, phosphates and carbonates follow in the order given. In Iwano's series of 487 calculi of the urinary tract, calcium oxalate stones were in the majority. Of 545 calculi analyzed by Ultzman 80.9 per cent were uric acid, 8.6 per cent phosphates of alkaline earths, 5.6 per cent calcium oxalate, 3.3 per cent

for Urology at the New York Hospital the following results were secured:

		Per Cent
Calcium oxalate	106	51.3
Phosphates... ..	79	38.2
Uric acid	16	7.7
Cystine	6	2.9

The oldest known calculus of the urinary tract in man, about 7000 years old, consists of a nucleus of uric acid and an outer portion of calcium oxalate and triple phosphate. It was found in 1901 by Elliott Smith in a pre-historic tomb at El Amrah,

* From the Brady Foundation for Urology, New York Hospital. Submitted for publication March 2, 1932.

near Abydos, and was discovered in the pelvis of a boy of about sixteen.¹

Of factors determining the predominant

in the urinary bladder, gall bladder and intestine.

Swain did considerable work in deter-



FIG. 3. Cystine calculus.



FIG. 4. Two calculi in ectopic (pelvic) kidney.

type of calculus in any geographical location diet is probably the most important. It is thought by many that the absence of the fat-soluble vitamin predisposes to stone formation. Among the Japanese and Chinese, whose diet is deficient in this vitamin, calculus disease is very common, while among the Esquimaux, calculi are almost never found. However, the problem of stone formation in the human body is far from complete solution.

In 1897, Swain² published a case in which diagnosis was made by means of the roentgen ray of a calcium oxalate renal calculus, measuring $1\frac{1}{8} \times \frac{7}{8} \times \frac{5}{8}$ inches. He stated that this was the first case of calculus definitely diagnosed by x-ray but he ventured the prophecy that it was only a matter of time until a more extended knowledge would render it possible to prove graphically the existence of calculus, not only in the kidney, but also

mining the irradiability outside the human body of calculi of different composition and was the first to experiment along this line although Chapins and Chauvel were the pioneers in the study of renal calculi by means of the roentgen ray. Swain tabulated his results with calculi of various types as follows:

Specific Gravity	Permeability to X-ray	Density of Shadow
Calcium oxalate	Biliary calculi	Calcium oxalate
Uric acid	Uric acid	Phosphates
Phosphates	Phosphates	Uric acid
Biliary calculi	Calcium oxalate	Biliary calculi

Swain also showed that short exposures were better than long ones and that calcium oxalate and calcium phosphate calculi showed most plainly. He was at a loss to explain why calcium oxalate calculi were

so common in Bristol and took no stock in the common belief that this situation was due to the character of the water

tolians were so much more self-indulgent than their fellows as to account for their increased liability to "mulberry" calculi.

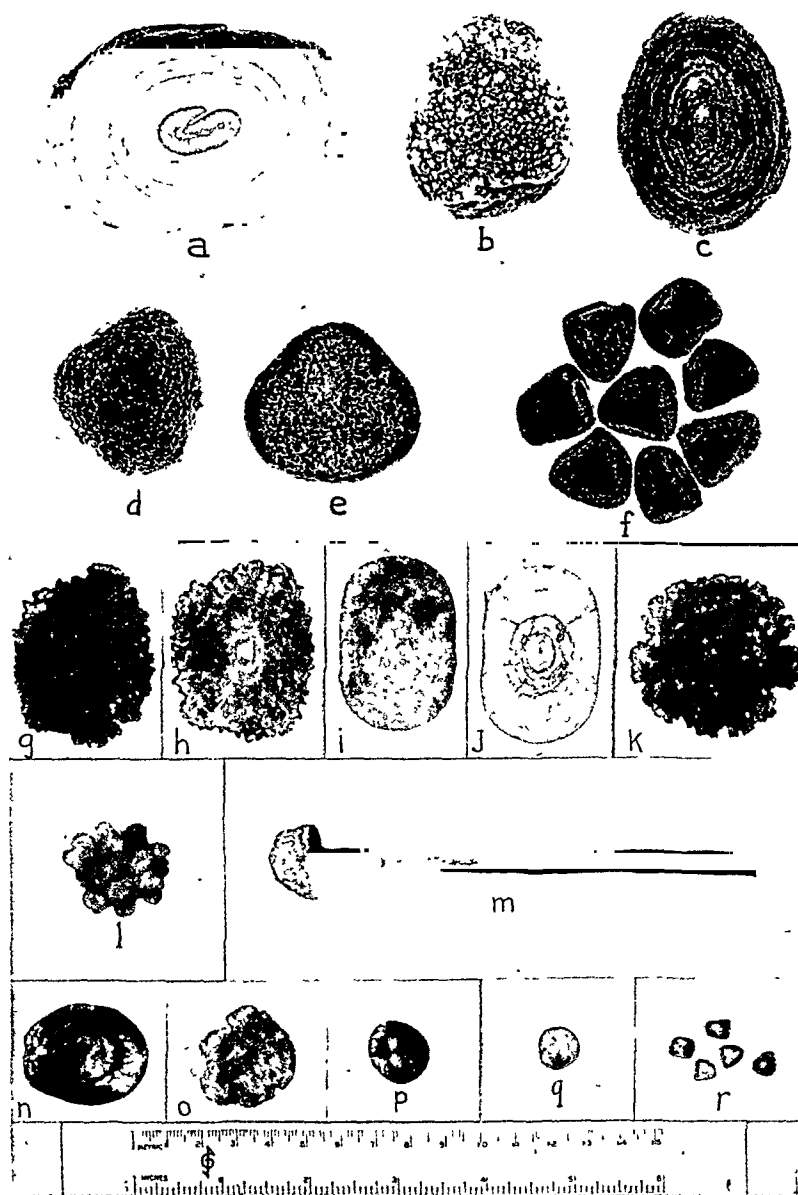


FIG. 5. Gross appearance of group of calculi of various compositions. (From Young and Waters.⁷)

a, calcium phosphate; b, uric acid with small amount of calcium oxalate; c, cross section of b; d, outer layer calcium phosphate, nucleus calcium oxalate and phosphate; e, cross section of d; f, calcium oxalate, carbonate and phosphate; g, calcium oxalate; h, cross section of g; i, uric acid with small amount of calcium oxalate; j, cross section of i, shell and nucleus examined; k and l, calcium oxalate; m, calcium phosphate deposits on mushroom catheter; n, calcium phosphate; o, calcium oxalate; p, uric acid; q, calcium oxalate; r, calcium oxalate, trace of uric acid.

supply. Some expressed the opinion that the condition was due to loose living among the inhabitants of Bristol but Swain said that it was difficult to believe that Bris-

Too much in turtle Bristol's Sons delight;
Too much o'er bowls of rack prolong the night:
If commerce fills the purse, she clogs the brain,
And Amos Cottle strikes the lyre in vain.³

A. Béclère⁴ tabulated the atomic weights of the elements entering into the composition of calculi and stated that the radi-

of ammonia, sodium urate, magnesium urate, potassium urate and calcium urate. Because of their greater atomic weight, the

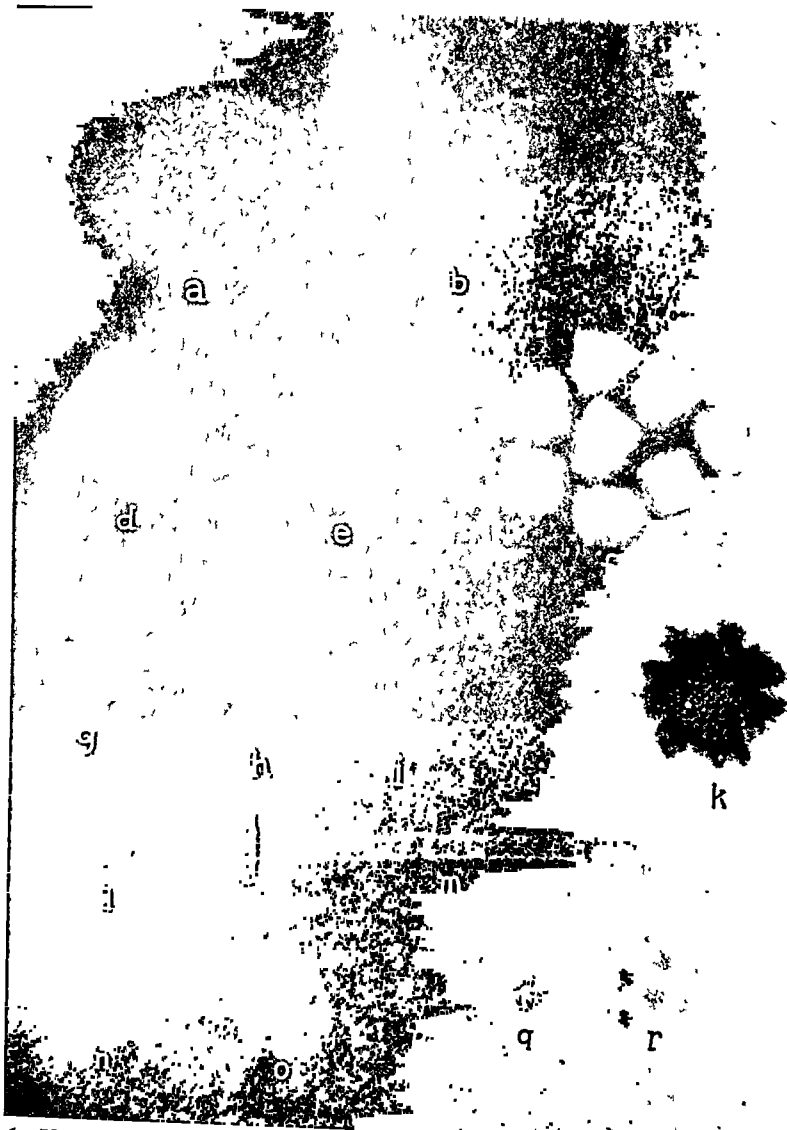


FIG. 6. X-ray appearance of same group of calculi. (From Young and Waters.⁷)

ability of calculi varies with the atomic weights, those made up of elements of low atomic weight having a slight power of absorption of roentgen rays. In the case of various salts, as carbonates, urates and oxalates, the power of absorption of the roentgen ray increases with the atomic weight of the metal entering into the composition; e.g., one can arrange the urates in order of their increasing capacity to absorb roentgen rays as follows: urate

salts of calcium have a power of absorption greater than that of salts of other bases. The atomic weight is not the only factor to be considered, however, as the number of atoms, in other words, the molecular structure, is also important. In calculi, layers of different density may alternate; e.g., a urate layer may alternate with a phosphate or oxalate layer. In this way a calculus could cast a shadow having the appearance of concentric circles.

About 10 per cent of urinary calculi cast no shadows at all. This is a point that many general physicians fail to recognize so that sometimes we have a patient come to us and say, "Dr. Jones thought I had a stone but the x-ray did not show it and so he said it must be something else." In some of these cases we nevertheless find filling defects in the pyelograms and remove calculi at operation. Such a case is illustrated in Figures 1 and 2. In Figure 1, a plain plate, no definite shadows indicating calculi are seen. In Figure 2, the pyelogram shows several filling defects which, at operation, were proved to be due to uric acid calculi.

The majority of calculi casting no shadow consist either entirely or largely of uric acid. When pure, a uric acid calculus gives rise to no shadow or to a very faint shadow. When visible, the density is usually due to contamination. Beer estimates that about 10 per cent of all urinary calculi consist of uric acid.

Calcium oxalate and phosphate stones cast a good shadow. Calcium carbonate stones are more frequent in lower animals than in man, but when found, cast a good shadow.

Cystine stones, if pure, cast faint shadows (Fig. 3). If they contain impurities the shadows may be quite definite. There are six cases of cystine calculi in the series classified at the beginning of this article. Three of these six cases of cystine stones have been previously reported by Henline.⁵

Xanthin and cholesterin stones are very rare and cast only faint shadows.

Soft stones in the urinary tract are rare. Hyman⁶ reported three cases of soft vesical stones which consisted of albumen, fibrin, bacteria and amorphous material mixed with urinary salts. In Hyman's cases the stones followed cystitis, subsequent to prostatectomy.

Small stones may not cause definite displacement of the medium employed. Usually, a stone must be at least 1.5 cm. in diameter to cause a recognizable filling defect. For this reason some small calculi

are missed even after a complete urologic investigation.

Figures 5 and 6 are used through the courtesy of Dr. Hugh Young and Dr. Charles Waters.⁷ These figures give a very excellent idea of the x-ray appearance of various types of calculi.

Some pyelographic media, such as colloidal silver, impregnate the stone so that its outline is visible several hours after pyelography. The iodide solutions usually employed today do not cause such impregnation.

Biliary calculi must be differentiated from those of the urinary tract. This is usually not difficult as biliary calculi are often in group formation, are more mobile and are in most instances more opaque around the periphery than at the center. The fact that a patient may have both biliary and renal calculi should not be overlooked. The author had such a case recently.

The position of calculi may at times be deceptive due to renal ptosis, double pelvis, horseshoe kidney or ectopic kidney. The author⁸ has reported a case of two calculi in an ectopic (pelvic) kidney. This case occurred on the service of Dr. O. S. Lowsley at the New York Hospital. The calculi are shown in Figure 4.

The most common sources of error in the x-ray diagnosis of calculi are as follows:

1. Faulty x-ray technique.
2. Motion or breathing on part of the patient.
3. Presence of gas in the intestines.
4. Overlapping of calculus and bone shadows.
5. Obesity of the patient.
6. Failure to make a complete cystoscopic examination with pyelogram.
7. Inexpert interpretation of the plates.

SUMMARY

The density of the shadow cast by a calculus varies with the atomic weight of the chemical elements of which the calculus is composed.

The composition of a series of 207 calculi is reported. Calcium oxalate stones predominate in this series.

Certain types of stones cast no shadows or very faint shadows.

A complete urological examination with pyelography is often necessary to rule out the presence of calculus.

Sources of error in the x-ray diagnosis of calculi are pointed out.

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* Continued from page 363.

RENAL DYSTOPIA

A REVIEW OF 343 CASES*

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THE insecure renal attachments, the structural anatomy of related parts and the generally lax physical habits

has been written and various therapeutic measures advocated, most of which have been surgical. However, the frequency with

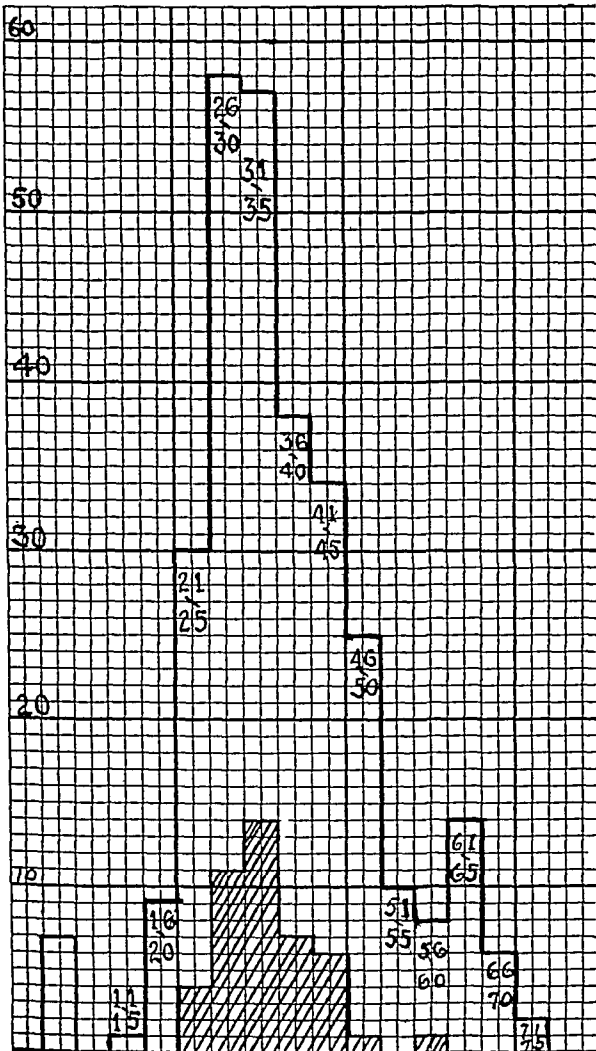


FIG. 1. Age incidence, males and females. Males in shaded portion.

are responsible in a large degree for renal dystopia and its attendant aggravating symptoms. Ptosis was first described in the fifteenth century, since then much

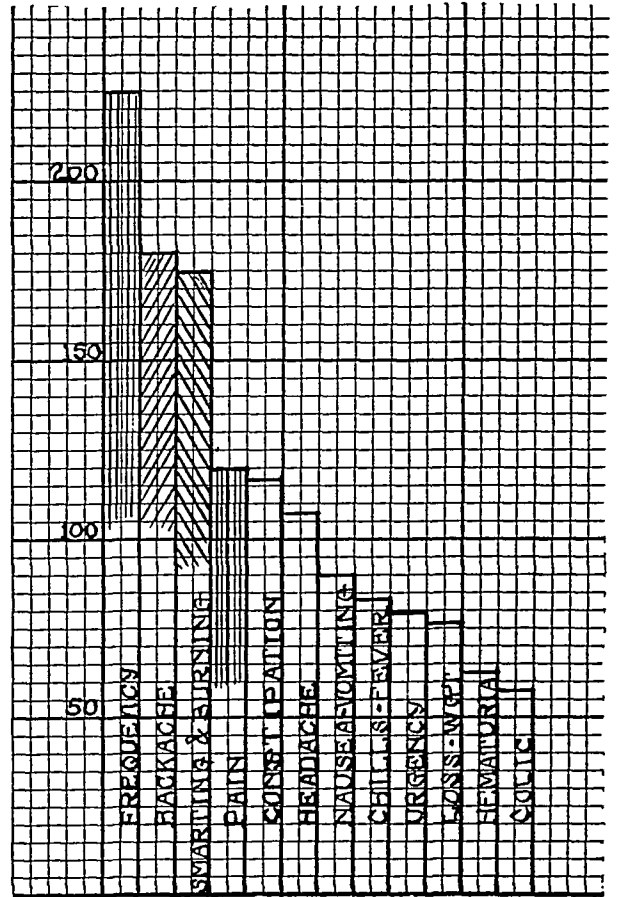


FIG. 2. Relative occurrence of symptoms in all cases.

which the condition has been found in the clinic (Woman's Hospital, Detroit) and the success of the non-surgical treatment employed, has led us to believe that a careful study of the case records of these patients might be of interest; accordingly we herewith present a résumé of 343 cases that have been under our care in the past few years. These patients have had a

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rather careful follow up which has assisted in completing the records.

Renal dystopia is rather difficult to

amount of motility of the kidneys in all affections of the higher urinary tract.

The severity of the symptoms is not

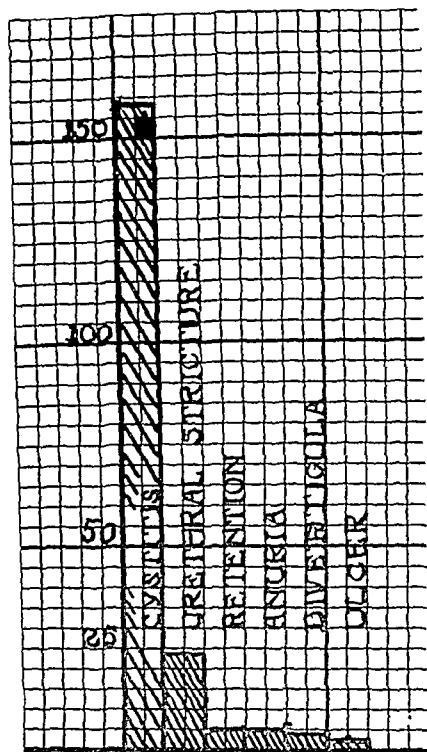


FIG. 3. Cystoscopic findings in all cases.

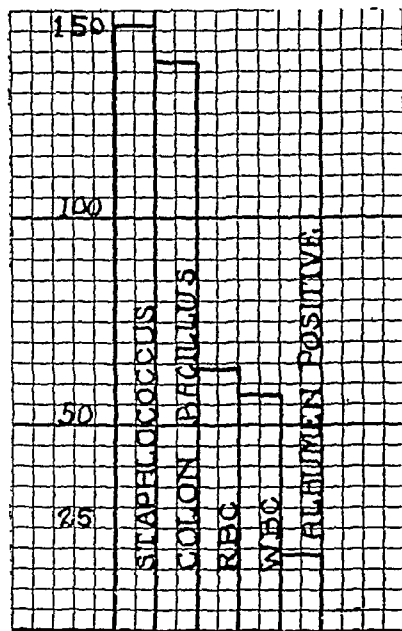


FIG. 4. Laboratory findings in all cases.

define except relatively. If the normal respiratory excursion of the kidney is from 1.5 to 5 cm., then any excess of this behind the peritoneum may be considered abnormal. Glenard's classification is as follows:

First degree: When the lower pole of the kidney can be felt on deep inspiration.

Second degree: When the kidney can be grasped near the middle on deep inspiration and held.

Third degree: When the entire kidney can be grasped and the hand pushed above the upper pole.

However, we feel that the careful interpretation of x-ray films is the most valuable aid in determining the degree of dystopia, and the degree of ptosis should be measured on the films. In an earlier publication, one of us (H.L.M.)¹ laid special stress upon the necessity of establishing the exact

always in direct proportion to the degree of dystopia. In fact patients having renal dystopia may be symptom free, especially uncomplicated cases. If the condition is discovered during the course of routine examination it perhaps would be inadvisable to inform the patient for obvious reasons. Conclusions should be arrived at only after careful, complete, and intelligent urological examination.

The entire surface of the kidney is covered by a thin, strong fibrous capsule, which dips down into the sinus and becomes adherent to the renal vessels. Next to the fibrous capsule is the perirenal fat which completely surrounds the organ. The renal fascia, which is one of the principal means of fixation of the kidney, is developed from the subperitoneal tissue lying between the transversalis fascia and the peritoneum. This fascia splits into two layers at the lateral border of the perirenal fat. The posterior layer passes anterior to the psoas muscle and posterior to the aorta where it fuses with the heavy

connective tissue in front of the vertebral column. The anterior layer, which is thinner than the posterior, passes over

lower costal margin acquired in some cases. In the male the lower chest has a greater width and the breadth of the pelvis is

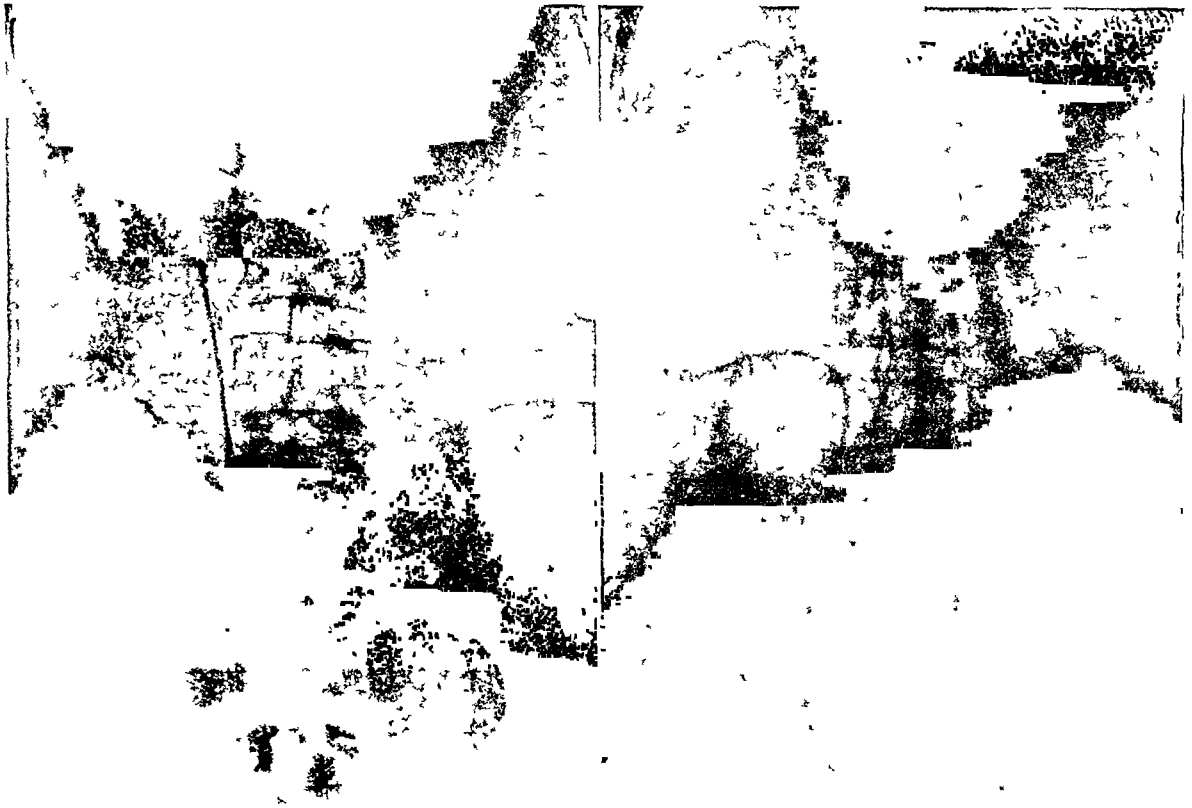


FIG. 5A

FIG. 5B.

FIG. 5A and B. Mrs. M. Two pyelograms taken in prone (A) and upright (B) postures illustrating degree of left dystopia.

the renal vessels and aorta and becomes continuous with the corresponding layer of the opposite side. The left anterior layer is somewhat stronger than that on the right, due to the doubling over of the mesocolon during development. Both layers are attached to the fibrous capsule by fine trabeculations traversing the fatty capsule. Superiorly the layers pass over the suprarenal gland and unite with each other. Below the kidney the layers remain separated, the space being traversed by the ureter, and are finally lost in the iliac region. Thus it may be seen that the renal fascia forms a tube which in the female resembles a cone with apex above. This is due to the relatively increased breadth of the pelvis and the narrowness of the

shorter, the renal fossae have a distinct pear shape with the narrower portion below.

In position the kidneys lie opposite the last thoracic and the first two lumbar vertebrae. The lower pole of the right kidney is about $\frac{1}{2}$ inch above the level of the umbilicus, the left about one inch above. The upper pole of the right kidney reaches to about the inferior border of the eleventh rib, while the left is at the superior border. The right kidney has further attachments consisting of folds of peritoneum extending from the liver, the hepatorenal ligament, and from the duodenum, the duodenal ligament. The left kidney is further supported by similar structures, the leinorenal ligament from

the spleen, and one of lesser importance from the pancreas, consisting of subperitoneal tissue. Both receive further support

4. Intra-abdominal pressure.
5. The various peritoneal and subperitoneal attachments just described.



FIG 6A.

FIG. 6B.

FIG. 6A and B. E. B. Two pyelograms taken in prone (A) and upright (B) postures illustrating bilateral dystopia and hydronephrosis.

from the diaphragm, the phrenicorenal ligaments.

Longyear² described a connective tissue band which he calls the nephrocolic ligament, extending from the colon to the lower pole of the kidney. He contends that nephroptosis is secondary to a coloptosis and is due to the pull of the colon on the ligament which displaces the kidney. It has been demonstrated, however, that this structure does not exist in the normal healthy individual.

Thus it may be seen that the kidney depends upon several factors for its normal position. They are in order of their importance.

1. The renal pedicle.
2. The renal fascia.
3. The fatty capsule.

Kidd³ lists four body types found with renal dystopia:

Type 1: Those individuals with lax abdominal muscles.

Type 2: Cases with compression of the hypochondrium.

Type 3: The ectopic or unascended kidney of the congenital type.

Type 4: The type with the narrow flat chest and narrow abdomen with good abdominal muscles and a weak nervous system, which he calls the "Egyptian" type.

We are not so much concerned with Type 2 in this country in the present generation, and Type 3 cannot be considered since renal dystopia is acquired. We can agree with Types 1 and 4 and as many other types as may be mentioned

because we do not believe that body type influences renal ptosis. It has been stated that long thin-chested individuals with

are supported on the horizontal layer of renal fascia which acts as a hammock.

Lenhoff⁷ states that patients with mov-



FIG. 6c.



FIG. 6d.

FIG. 6c and d. R. K. Two pyelograms illustrating bilateral dystopia and kinked right ureter.

sharp costovertebral angles are more prone to dystopia than are short thick-set people. As will be seen from the illustrations practically all body types are represented.

Wolkow and Delitzin⁴ believed body form to be a factor in dystopia and evolved a formula of mensuration in which they divided the distance from the sternal notch to the symphysis by the circumference of the abdomen and multiplied by one hundred. If the result was 77 or over, the individual was considered to have dystopia; if the result was 73 or less dystopia did not exist.

Harris⁵ of Chicago confirmed these findings. Southam⁶ believes man to be predisposed to dystopia because of the erect position. In quadrupeds the kidneys

able kidney were found to have a distinct contraction or diminution in the capacity of the middle zone of the body. Sinkler⁸ believes the most common cause of dystopia to be the loss of perirenal fat.

Women are particularly prone to renal dystopia because as they approach maturity the pelvis broadens, the pelvic outlet becomes larger, and the funnel of renal fascia even wider at its base than before. Post partum the intra-abdominal pressure is lessened due to the laxity of the muscles of the abdominal wall and perineum. The fatty capsule and other fat deposits are diminished allowing the trabeculae to sag. Assuming arduous duties too soon after parturition, before muscular tone has been restored, and the use of improperly fitting

supports or none at all tend to increase the motility of the organ. Congenital anomalies of the pedicle and other attachments are

and therefore is dependent upon congenital predisposition.

Bell¹¹ believes that congenital constitu-

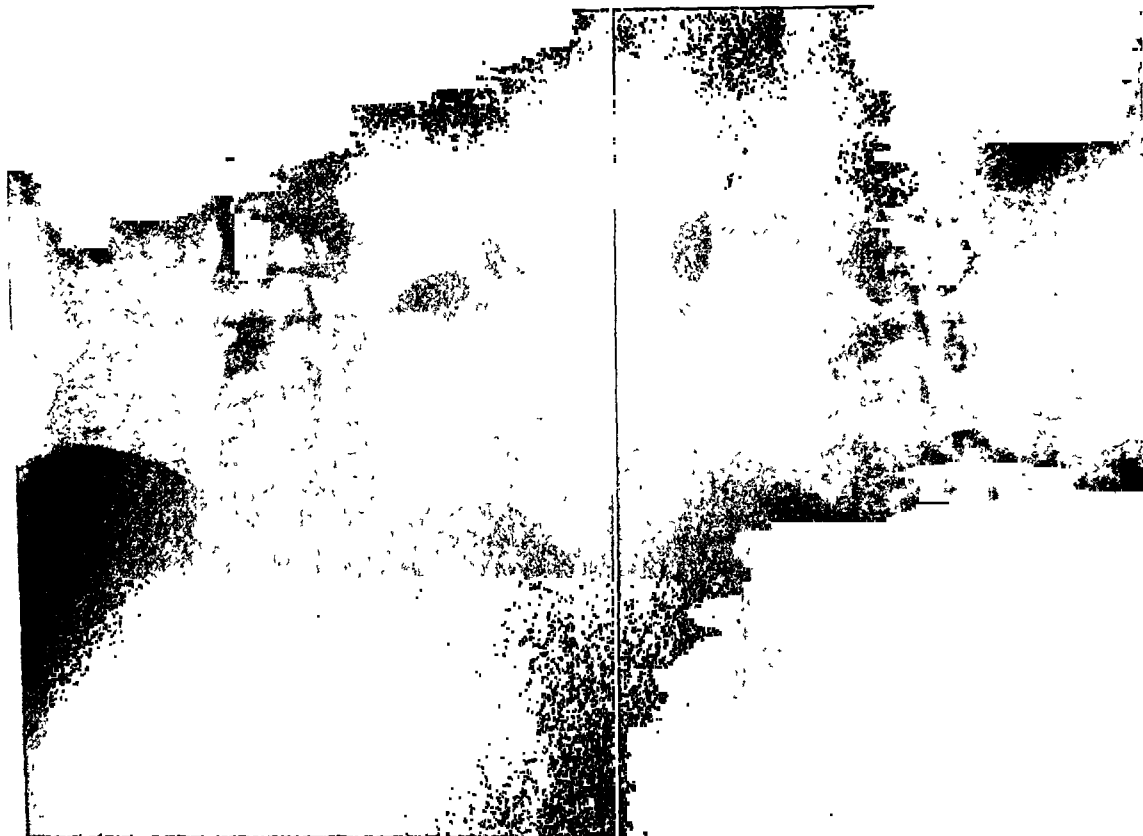


FIG. 7A.

FIG. 7B.

FIG. 7A and B. B. A. Right dystopia.

responsible in many instances for increasing the symptoms. Aberrant vessels distorting the course of the ureter, decreasing its lumen and obstructing the flow of urine add to the symptoms. Repeated body jars, as may be sustained by certain occupations or forms of exercise, may constitute sufficient trauma to gradually increase renal motility. Harris⁵ states that movable kidney does not occur suddenly as a result of a single trauma except in cases of predisposing body type. Mathe⁹ believes that severe injuries seldom are followed by movable kidney; as a matter of fact the kidneys are more firmly fixed than ever, and that a single injury never results in dystopia. Movable kidney requires time to develop. Albarran¹⁰ thinks movable kidney is in reality a body stigmata of degeneracy

tional tendencies are the etiological factors in the majority of cases. He does not believe that pregnancy influences dystopia. In his series of 300 cases, 50 per cent of the women were nulliparous or unmarried.

In our series 40, or only 13.3 per cent, were unmarried, and while this does not disprove Bell's statement we are rather inclined to believe that the urinary stasis resulting from the mechanical obstruction produced by pregnancy is certainly a large contributory factor to the various complaints associated with dystopia.

The right kidney is more frequently involved than the left. This may be accounted for by the longer renal pedicle, and the fact that violent respiratory activities are transmitted to the right kidney directly by the solid liver and the

fact that the anterior renal fascia on the right is weaker than on the left.

The diagnosis of dystopia cannot be

exercised not to overdistend in any one place by too rapid injection. Exposure is made with the patient prone. The table



FIG. 7C.

FIG. 7D.

FIG. 7C and D. M. G. Right dystopia and tortuous ureter.

properly made without the aid of pyelograms in two postures. It has been our practice to do simultaneous bilateral pyeloureterograms under fluoroscopic control as has been described by one of us (H.L.M.¹²). Many operators advise against this practice, but under fluoroscopic control the exact location of the catheter tip is definitely determined. It should be just within the ureteropelvic junction. The injection then of opaque medium does not produce spasm. The degree of filling of the pelvis may easily be determined. The catheter may then be withdrawn and the medium deposited along the lumen of the ureter, care being

is then raised to the vertical position, the patient standing on a platform fixed to the table. We prefer to have the patient standing on his feet as we do not believe we get a true interpretation of the degree of renal motility with the patient in a sitting position. The necessity of a motor-driven fluoroscopic table for the correct diagnosis of dystopia is readily seen. The degree of dystopia, the presence of rotation, the relative course of the ureters may then readily be visualized. A grooved holder on the under side of the fluoroscopic screen accommodating an 8 by 10 inch cassette enables us to record any particular pathology. A third exposure is routinely

made ten to fifteen minutes later to determine the retention of pyelographic media, indicating the degree of urinary stasis.

pain. The distribution of this pain occurred 42 times in the right lumbar region as compared to 27 times in the left, while 41

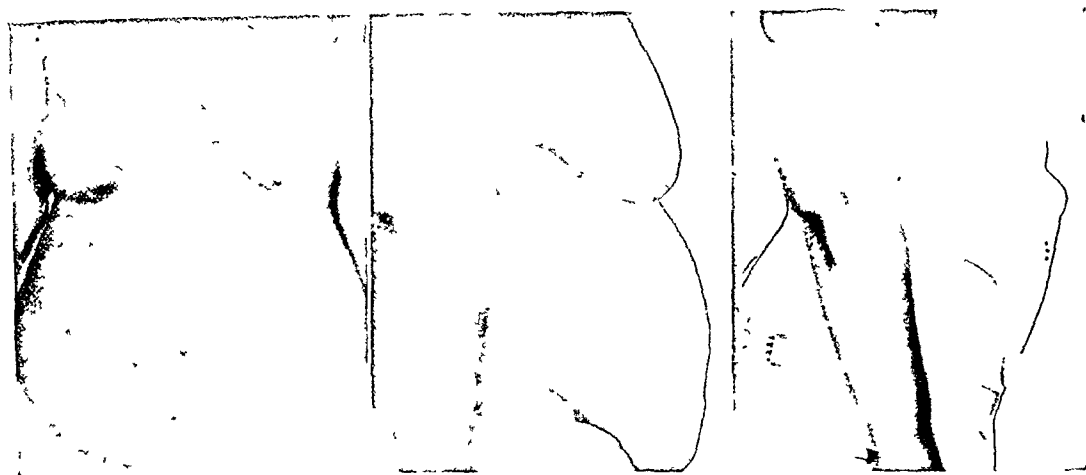


FIG. 8. Views of trunk, front, lateral and with belt adjusted. Age, fifty-six. Height 5 ft. 4 in. Weight 208 lb. Circumference measurements: Umbilicus $40\frac{1}{2}$ in. Trochanteric $49\frac{1}{2}$ in. Distance between costal margin and crest of ileum 4 in. Distance from ensiform to pubes 16 in. Bilateral dystopia $1\frac{3}{4}$ in. Bifid pelves, grade two. Relief on wearing belt.

In this series there were 299 females and 44 males, or in a ratio of 6 to 1. The youngest was a girl of fifteen years and the oldest seventy-five years of age. Most of the women were in the child-bearing age, 115 cases occurring in patients between the ages of twenty-six and thirty-five inclusive. The number of cases decreased as the age increased, although 14 patients were seen whose ages were between sixty-one and sixty-five. In the male patients findings were similar. Twenty-six of the 44 were between the ages of twenty-six and thirty-five. This was undoubtedly due to the fact that men up to this age indulge in more strenuous exercise and harder work than after this period. The accompanying chart (Fig. 1) shows graphically the ages and number of cases occurring in each group. In seven the age was not stated.

The predominating local symptoms were those of urinary tract infection and stasis. Two hundred and twenty-two complained of frequency; 173 of smarting and burning; 79 of urgency; 82 of chills and fever. Backache occurred in 179. One hundred and seventeen patients complained of

patients complained of bilateral lumbar pain. This group is separate from those complaining of backache. Fifty-six patients had distinct renal colic as first described by Dietl. Eight complained of abdominal pain. Hematuria occurred in 61 cases, which was due to pyelitis or ureteritis, as only one of this group was diagnosed as calculus. Constipation as a general complaint was rather common as would be expected in this class of patient, occurring in 114 instances.

Headache, nausea and vomiting are shown on the chart (Fig. 2) not so much in connection with the urinary tract complaints as in the general group indicating toxemia, for certainly dystopia and the resultant stasis in the majority of cases is not confined to the urinary tract alone.

Bell states that in addition to the direct symptoms there are the reflex symptoms due to the autonomic nervous system. The kidney pulling on its pedicle irritates its nerve, the trauma is transmitted to the proximal ganglion which in turn affects the whole sympathetic system which might easily be responsible for

causing functional changes in any viscus supplied by the system. This may explain the variety of symptoms manifest in this

On urological examination 28 were found to be suffering with right renal dystopia and one with right renal calculus. Sixty



FIG. 9. Mrs. J. Views of trunk: front, lateral and with belt adjusted. Age, twenty-five. Height 5 ft. 1 in. Weight 151 lb. Circumference measurements: Umbilicus 38 in. Trochanteric 40 in. Distance between costal margin and crest of ileum 2 in. Distance from ensiform to pubes 14 in.

disorder. He also explains the pelvic complaints by stating that pressure on the ovarian vein by a sagging kidney is responsible for ovarian congestion. The various nervous and hysterical manifestations which are generally conceded to accompany this condition were not noticeable in this group.

The cystoscopic findings (Fig. 3) were those of cystitis alone. Two hundred and eighty two cases were found to have infected urines: staphylococcus in 145; colon bacillus in 137. Ureteral obstruction occurred in 35 cases.

The pyelographic findings are shown in the table for convenience:

	Left	Right
Hydronephrosis.....	39	84
Blunted calices.....	33	72
Pelvic retention.....	9	15
A aberrant vessel.....	11	17
Hydroureter.....	37	57
Tortuous ureter.....	51	71
Dystopia.....	18	113
Dystopia—bilateral.....	212	

It was interesting to note in this regard that 97 patients had had previous appendectomies performed; 29 of these patients still complained of their symptoms.

patients had had pelvic operations, e.g. hysterectomy, oophorectomy, salpingectomy, and uterine suspension. Twelve of these still complained of their symptoms; further examination revealed the cause to be dystopia. Twenty per cent were evidently subjected to the risk and discomfort of a major operation without sufficient evidence to warrant the treatment. Two out of 12 operated on for gall-bladder disease still had persistent symptoms not relieved by operation and were found to have dystopia. In each case the correction of the dystopia plus the routine treatment of urinary infection resulted in relief of the discomfort.

The intermittent urinary stasis in dystopia resulting from ureteral obstruction over a long period of time with subsequent dilatation of the renal pelvis and flattening of the papillae predisposes to infection, calculus formation, and other urinary tract pathology, and is responsible for various degrees of pain. The disturbance of the sympathetic nervous system caused by irritation from tugging at the renal pedicle undoubtedly is responsible for various complaints which might

easily be attributed to other organs. Sturmdorff¹³ in a recent publication dealing with pelvic disorders totally ignores renal

ther states that denervated kidneys are just as efficient as normal kidneys under stress.

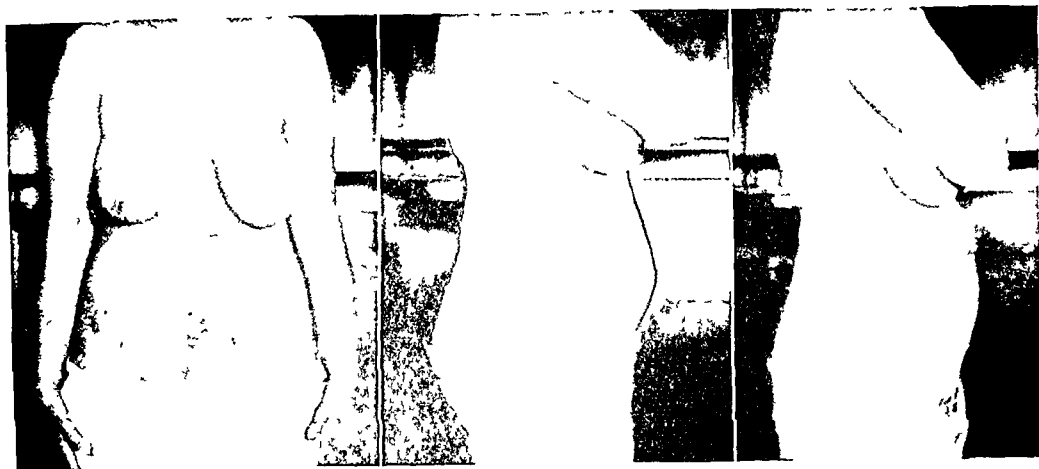


FIG. 10. Mrs. K. Views of trunk: front, lateral and with belt adjusted. Age, twenty-three. Height 5 ft. 2 in. Weight 123 lb. Circumference measurements: Umbilicus 38 in. Trochanteric 33 in. Distance between costal margin and crest of ileum $2\frac{1}{2}$ in. Distance from ensiform to pubes 14 in. Bilateral renal dystopia, with grade two pelves. Marked relief on wearing belt.

dystopia as a causative factor in backache, and Bullard¹⁴ states in his analysis of backache that "in fifteen cases out of every hundred the backache persisted after otherwise successful correction of gynopathic conditions." It has been observed in our series that 169 patients had previous operative procedures, and it already has been noted that 32 of these, or 20 per cent, still complained of their symptoms. It seems significant how nearly this figure coincides with that of Bullard. These patients on investigation were found to have dystopia. We think it is safe therefore to assume that from 15 to 20 per cent of all cases of backache are due to renal dystopia.

Hess¹⁵ reports the success of renal sympathectomy for the nephralgia accompanying floating kidney. He states that these patients are relieved of their pain and gastrointestinal symptoms; that denervated kidneys produce about one-fifth more urine than their unoperated fellow organs; that the urine from a denervated kidney is but of slightly less specific gravity, and that there is more propulsive force to the ureteral jets of urine. He fur-

The term nephralgia aptly describes the backache characteristic of renal dystopia.

Since the advent of pyelography the diagnosis of renal dystopia should rarely be confounded with tumor of the colon, enlarged spleen, gallbladder disturbances, enlarged lobe of the liver or pelvic disorders. The colic of renal calculus disease may also be differentiated from Dietl's crisis by the use of the x-ray. Suspected chronic appendicitis deserves the precaution of a urological examination to rule out the possibility of renal dystopia.

TREATMENT

Hahn of Berlin in 1851 performed the first nephropexy; Weir, 1882, was the first in America. Bell states that the method of choice in the treatment of dystopia is nephropexy, as does Billington¹⁶ in his recent publication on movable kidney.

Mathe states: "Surgical suspension has fallen into disrepute, not on account of inefficiency, but because it has been performed when it has not been indicated. The technique has been faulty or there has been failure to realize the necessity of exposing the ureter and relieving any

condition which might be present, which unrelieved would defeat the purpose of the operation." Lowsley¹⁷ used belts in

It is absolutely essential that the belt be properly fitted and that it be applied while the patient is recumbent. The use of



FIG. 11. Mrs. L. Views of the trunk: front, lateral and with belt adjusted. Age, twenty-four. Height 5 ft. 6¼ in. Weight 113½ lb. Circumference measurements: Umbilicus 28½ in. Trochanteric 38 in. Distance between costal margin and crest of ileum 4 in. Distance between ensiform and pubes 12½ in. Egyptian type. Right dystopia with small hydronephrosis. Left normal.

his cases, and if after trial these fail to produce the desired result, nephropexy is performed. Kretschmer¹⁸ employs the same procedure. Braasch¹⁹ states that there were only 23 cases in which nephropexy alone was performed at the Mayo Clinic. Young says: "The ultimate results of nephropexy have proved less favorable in cases followed for a long time, and the other forms of treatment have shown better results when faithfully carried out." Elam²⁰ believes that "uncomplicated cases are certainly operative as nephropexy will unquestionably relieve the symptoms produced by a ptosed and movable kidney, and may even admit of reaction of a kidney in which structural changes are beginning."

The uniform success of a proper support, properly applied, with the addition of symptomatic treatment of urinary infection and stasis, has led us to believe that nephropexy should be employed only as a last resort in the treatment of uncomplicated ptosis, but if the kidney cannot be placed in its normal bed; if there are adhesions or other anatomical changes which prevent its return, surgical correction is indicated.

kidney pads should be discouraged because the excessive pressure produced by a pad over a small area is not only uncomfortable, but its continued use lessens circulation and causes muscular atrophy at that site. Patients after long-continued use of trusses illustrate this point. If a patient is careless in applying such a support and the pad occurs above the kidney the dystopia is increased. A properly made belt should be back laced, quickly and easily adjusted, be made of duck or other non-elastic material and should not employ a pad. It should extend from just below the gluteal fold to the second or third lumbar vertebra behind. In front it should extend from the lower border of the symphysis to the umbilicus, but not above. Such a belt has several advantages beside correcting dystopia. It relieves symptoms. It is comfortable and improves the figure. Too much importance should not be attached to the opinion that support tends to decrease muscle tone. The majority of women employ the use of some type of abdominal support; why not one with some therapeutic value?

The value of diet is questionable in the treatment of dystopia, except as a general measure. The addition of weight will

dred and seventy-five patients received no form of treatment other than belts and of these 146, or 92 per cent, state



FIG. 12. Miss B. Views of trunk: front, lateral and with belt adjusted. Age, twenty-two. Height 5 ft. 7 $\frac{1}{4}$ in. Weight 104 $\frac{3}{4}$ lb. Circumference measurements: Umbilicus 36 in. Trochanteric 34 in. Distance between costal margin and crest of ileum 3 in. Distance from ensiform to pubes 14 in. Right scoliosis. Bilateral dystopia. Both pelves grade two.



FIG. 13. Miss B. Views of trunk: front, lateral and with belt adjusted. Age, forty-two. Height 5 ft. 9 in. Weight 107 lb. Circumference measurements: Umbilicus 33 in. Trochanteric 26 in. Distance between costal margin and crest of ileum 3 in. Distance between ensiform and pubes 12 in. Note the marked disproportion between trunk and iliac crests which necessitated accurate fitting of belt. Bilateral dystopia.

not materially assist in the correction of dystopia, neither will rich diet meet with the approval of an already overweight individual.

In this series, 202 patients were treated with belts, ureteral dilatation and pelvic lavage. Of these, 152, or 75 per cent, were relieved of their symptoms and required no further treatment. One hun-

that they have been cured. Only 6 cases of uncomplicated renal dystopia, or 1.7 per cent, had nephropexy performed. All other operative procedures were performed for co-existing complications which demanded surgery and should not be classed as nephropexy.

Although most any operative procedure involving the kidneys is more or less

responsible for the firmer fixation of these organs, as any one can testify who has had occasion to expose a previously operated kidney. Care should therefore be exercised to return a kidney to its proper bed before closure, to ensure proper drainage of urine.

A brief abstract of the six nephropexies follows.

CASE I. Mrs. M. S., No. 138, aged twenty-one, married, one pregnancy. Reported January 7, 1924, complaining of backache and loss of weight. Right kidney palpable, both renal areas tender to fist percussion. On cystoscopy both urines were found concentrated and contained many specks. Phenolsulphonphthalein test revealed some damage to right kidney function. Right culture grew staphylococcus. Bladder urine grew *B. coli*. Pyeloureterograms showed the right pelvis to be Grade 2. Considerable stasis was noted, the pelvis remaining full after thirty minutes. Dystopia of 2 inches was noted on right side and a diagnosis of aberrant renal vessel was made. She was supplied with a belt and treated symptomatically until symptom free. Patient reported four years later, having been comfortable in the meantime. She then gave a history of exposure to cold and wet, followed two weeks later by right renal pain. Examination revealed much the same pathology as before noted. Patient was fitted with a belt. X-ray with belt in place showed kidneys held in normal position. She had no further complaints until April 4, 1929. Following a long motor trip she complained of a constant, severe backache, bilateral. She was fitted with a new belt and was given pelvic lavages. Following this she was comfortable until January 11, 1930, at which time pyelograms showed a small beginning hydronephrosis and s-shaped kink on the right side. Nephropexy was advised. Accordingly she was operated upon March 14, 1930 under spinal anesthesia. When last seen, August 29, 1930, the urines were clear from both kidneys, the patient was comfortable and had no urinary complaints.

CASE II. Miss M. H., No. 1685, aged seventeen, single, no pregnancies. Reported May 24, 1927. She had been complaining of constant right renal pain, which one year

previously had become so severe that she was hospitalized. It was diagnosed appendicitis and she was operated on without relief of symptoms. The right kidney was palpable, the lower pole very tender, and there was very pronounced tenderness along the course of the right ureter. A pyelogram revealed a right-angled turn laterally to the border of the psoas muscle and another right-angled turn at the ureteropelvic junction on the left side. The right ureter was dilated and had an s-shaped kink. There was a dystopia of $2\frac{3}{4}$ inches on that side. Two different types of abdominal support were tried but without success. She was admitted to the hospital October 27, 1927. A right nephropexy and sympathectomy was done October 28, 1927. Recovery was uneventful and she was discharged November 18, 1927. She was last seen January 19, 1928, with no urinary complaints. Urine was clear and sterile.

CASE III. Mrs. C. P., No. 1415, forty, married, para six. Reported August 27, 1926, complaining of frequency, burning and smarting, urgency, backache, headaches, for the past year. She had definite tenderness over both ureters, especially the left. Cystoscopy showed a mild generalized cystitis, left ureterocele, and trigonitis. Urines at this time showed many pus cells and *B. coli*. Pyelograms in the upright position showed the left kidney to be at the crest of the ileum, the right below the crest of the ileum. Patient was fitted with a belt and given pelvic lavage. She was then comfortable until February 26, 1927, when she reported complaining of right renal pain. Right kidney urine was turbid and contained pus. The belt was readjusted and on x-ray examination apparently allowed no abnormal renal excursion. She next reported January 29, 1929 wearing a corset not designed to correct dystopia. She had been complaining for the past two months of right renal backache and bladder symptoms. Right kidney urine at this time was turbid and contained red blood cells. She was advised regarding support and in the event it proved unsatisfactory to have surgical correction. The patient was carried along on symptomatic treatment until October 2, 1930, when she had a right nephropexy performed. She made a good recovery, was discharged November 21, 1930, with incision healed and no urinary complaints.

CASE IV. Mr. E. B., No. 1790, aged thirty-eight, factory worker. Reported September 30, 1927, complaining of severe pain in the right renal region. Pyelogram showed a Grade 2 right pelvis and a dystopia of $1\frac{1}{2}$ inches with a sharply angulated ureteropelvic junction. He was supplied with a belt and treated with pelvic lavage until April 7, 1928, at which time pyelogram showed an increase in the size of the right renal pelvis, calices more blunted and a dystopia of 2 inches, and the ureter more tortuous. He was admitted to the hospital and on April 12, 1928 a right nephropexy was done. Adhesions were found in the middle third of the ureter which prevented the return of the kidney to its normal bed. Recovery was uneventful; discharged April 28, 1928. He was last seen February 7, 1930. There were no urinary complaints.

CASE V. Mrs. F. R., No. 1817, aged thirty-seven, factory worker. Admitted to clinic September 20, 1927, complaining of pain in right hypochondrium, dull, nagging in character, referred to the region of the right shoulder blade, and of one year's duration. Pyelogram showed right kidney to be rotated, the pelvis was considerably dilated, moderate hydronephrosis and some dystopia. She was admitted to the hospital and on October 7, 1927, a right sympathectomy and nephropexy were done. Recovery was uneventful and she was discharged from the hospital October 21, 1927, with wound healed, patient feeling comfortable. X-rays taken December 14, 1927 showed the kidneys in normal position with a motility of $1\frac{1}{4}$ inches.

CASE VI. Mrs. M. M., No. 2163, aged thirty-three years, married, no pregnancies, housewife. Reported August 9, 1928. Complained of right lumbar pain of more than one year's duration, smarting and burning, and headaches. She had had an appendectomy performed one year previously with no relief of symptoms. On examination she had a palpable tender mass in the right side of the abdomen. Tenderness extended along the

course of the right ureter. On cystoscopy the right ureter was catheterized to a point about midway, where an obstruction was encountered, which could not be overcome. Pyelograms revealed a right renal dystopia of $2\frac{3}{4}$ inches with resultant tortuosities of the ureter. She was supplied with an abdominal support. X-rays taken October 12, 1928, with support in place showed no correction of ptosis. She was admitted to the hospital and on October 25, 1928, a nephropexy was done. Recovery was uneventful. She was discharged November 12, 1928. X-ray taken December 7, 1928, showed normal motility of the right kidney.

The foregoing abstracts show the importance of frequent and thorough examination of these patients. They are prone to become careless in applying their supports, need readjustments and occasionally active treatment to control their infection.

CONCLUSIONS

After careful consideration we feel justified in arriving at the following conclusions:

1. These findings are the results obtained from a study of 343 cases of renal dystopia.
2. Body type does not influence renal dystopia.
3. The predominating symptoms of renal dystopia are those of urinary infection, stasis and backache, aptly termed nephralgia.
4. Fifteen to 20 per cent of all cases of backache are due to renal dystopia.
5. The proper diagnosis and interpretation of x-ray films are dependent upon the method of procedure.
6. In the great majority of cases of renal dystopia satisfactorily fitting belts, properly applied, plus routine treatment for urinary infection, have given complete relief of symptoms.
7. Nephropexy is seldom indicated in the treatment of renal dystopia.

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[For Remainder of References see p. 433.]

A CASE OF CAVERNOUS HEMANGIOMA OF THE BLADDER*

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HEMANGIOMA of the bladder is probably the rarest of all neoplasms of the bladder. Assisted by the Librarian of the American College of Surgeons, 16 cases of hemangioma have been found in the literature. The first mention of such growths is that of GROSS in his treatise on the urinary organs, 1851. A soft, cauliflower-like tumor was found, at autopsy, in the bladder of a woman aged seventy-two. No histological description is given. The first authentic case appears to be that of Langhams, who is credited by Clado as having found a hemangioma, in 1879, at necropsy of a boy, aged nineteen, who had died of hematuria. The largest part of it was on the posterior vesical wall, where the mucosal and submucosal layers were composed of cavernous tissue.

Albarran, in 1892, observed a hemangioma at necropsy of a man aged sixty-four, who had died following operation by Guyon. The patient had suffered from hematuria. The tumor was submucosal and the bladder epithelium was well preserved. Histological examination showed capillary dilatation surrounded by connective tissue.

At the Clinical Society in London, 1895, Lane reported a case of extensive degenerating nevus of the bladder in a child, aged three and one-half years. Two years before admission to the hospital the child commenced to pass bloody urine, at times large flat clots; occasionally there was profuse hemorrhage. Scattered about the anus and buttocks were a few small patches of degenerated nevoid tissue and their presence led to the diagnosis that the bladder

condition was also nevoid. The mass in the bladder could be felt distinctly both above the pubes and by the rectum.

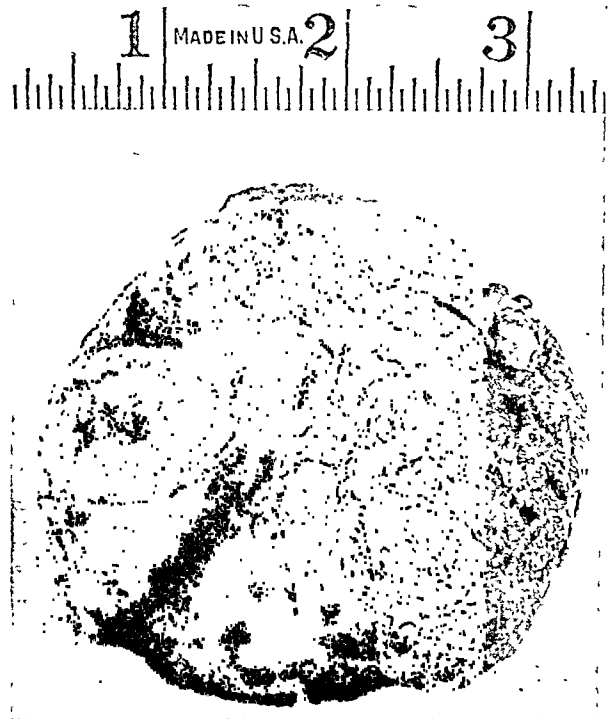


FIG. 1. Hemangioma of bladder. Rule above is in inches.

Suprapubic cystotomy was done and large angiomatous masses protruded through the incision. Almost all of the mucous membrane was involved. Excision seemed inadvisable. For some unexplained reason the child's condition improved greatly after the operation. The final outcome is not recorded.

Jungano, in 1907, described a massive cauliflower angioma, in the region of the trigone, undergoing sarcomatous degeneration in a man aged fifty-four years.

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Bryan reported, in 1909, a typical cavernous angioma which was removed by suprapubic cystotomy.

with blood; the other part was soft and the connective tissue was infiltrated with small blood clots.



FIG. 2. Photomicrograph of hemangioma of bladder.

Judd and Harrington reported, in 1918, a case of angioma in a woman, nineteen years of age, who had complained of incontinence for two years. The tumor was the size of a large grapefruit. The bladder was greatly hypertrophied and there was an area in the right anterior wall of the bladder through which the growth extended into the right extravescical space. The pathological diagnosis was papillary angioma.

Launay, Achard and Carriere saw, in 1920, an angioma of the right bladder wall. The tumor was composed of two parts; one part, globular and very hard, was composed of connective tissue in which blood vessels were dilated and filled

Scholl, in 1920, reported, from the Mayo Clinic, three patients with tumors of the bladder which were classed angiomata:

CASE 1. A girl, aged nineteen, had had pus and blood in the urine and mild incontinence for two years. At operation a large polypoid tumor was found filling an enormous bladder. The tumor extended into the prevesical space through an area about 3 cm. in diameter. A slight recurrence three months later was successfully fulgurated and five years later the bladder was normal.

The tumor was firm and contained many blood cysts and sacculations, but the largest part of the growth was composed of interlacing blood vessels supported by connective tissue.

CASE II. A man, aged seventy-six, had had occasional moderate hematuria for eight months. An inoperable sessile growth, covered with papillomatous excrescences, was found on the left base of the bladder. The growth was extensively fulgurated but seventeen months later the symptoms returned. There was a widespread mass covering the entire left half of the bladder and involving the prostate and posterior urethra.

CASE III. Girl, aged seven, with slight hematuria which had persisted for six years. Some blood had passed by rectum. A mass, 6 cm. in diameter, was palpated in the region of the bladder. Death followed severe rectal hemorrhage. Necropsy revealed an extensive cavernous angioma growing from the base of the bladder and invading the rectal mucosa.

Rafin, in 1920, saw a diffuse angioma in the bladder of a girl, aged seventeen, who had recurrent hematuria from the age of four years. Cystoscopy showed the trigone, interureteral zone and ureteral orifices were normal. The remainder of the bladder presented two aspects; one was characterized by small red grains separated from each other by exceedingly distinct small, white spaces. A few islands of normal tissue were interspersed. In other regions there were large bluish blood vessels and islands circumscribed by the same bluish color, with a moderate degree of projection. Some of these were about to ulcerate. The general aspect was that of a diffuse nevus, not involving the entire surface. Surgical intervention was avoided because of the diffuse character of the angioma.

Faeber, in 1922, observed in a girl, aged eleven, who began to have hematuria when five years of age, a case of hemangioma of the bladder. The bleeding recurred at intervals but there was no pain at this nor during the succeeding five years. Cystoscopy showed a large hemangioma of the bladder. The growth was removed partly by excision and partly by Paquelin cauterization.

Kidd, in 1923, reported an angioma of the bladder removed at operation. The patient, a man aged twenty-nine, had developed acute retention two years previ-

ously. The tumor was smooth, pedunculated, and looked like a red raspberry, although about the size of a date.

Caulk, in 1925, reported a small hemangioma of the bladder wall which had the appearance of an ordinary nevus. The small, bluish, bleeding elevation was destroyed by fulguration.

Caulk also reported in the same article a pulsating cavernous hemangioma of the ureter, simulating inoperable carcinoma of the bladder. He was unable to find in the literature a single case of hemangioma of the ureter.

Marion, Huber, Okazaki, and Katz each have reported a case of cavernous angioma.

While somewhat irrelevant in the present discussion, it seems of interest to note that hemangioma of the kidney is about as rare as it is of the bladder, and very difficult to diagnose. The presence of hemangioma of the kidney should be suspected when all other possible lesions are ruled out and when the onset of renal bleeding is sudden and severe. Mackey, in 1930, reviewed the literature. He was able to find only 17 cases of hemangioma of the kidney in addition to one which he reported. Since this time Bailey has reported one other case.

CASE REPORT

White male, aged twenty-seven. The family history and the past history are irrelevant, except the urinary symptoms. The physical examination was practically negative except that a large mass could be felt in the bladder.

Present Illness. Father states that the patient had the first attack of frequent, painful and bloody urination at the age of six months. These attacks recurred from time to time and lasted usually five or six days, but occasionally for two or three weeks, the longest was five weeks. Until the patient was eleven years of age these attacks came on once a month or oftener; after that the time between the attacks was from one to five years. The patient had a very severe hemorrhage in 1929 and was confined to bed for twelve days. His parents had been told that he had an incurable cancer.

In spite of repeated hemorrhages, the blood count and hemoglobin were essentially negative. Upon admission to the hospital the patient complained of a feeling of fullness and pain in the region of the left kidney and ureter. A uroselectan picture showed the ureter and pelvis to be slightly dilated.

Cystoscopy showed a tumor about the size of an orange, no pedicle could be seen. Part of the surface of the growth was covered with closely set cysts about the size of split peas. These cysts were of many colors; most of them were greenish yellow. There were occasional bleeding points. The cystoscopy picture was not that of papilloma or carcinoma. Different parts of the tumor, however, looked quite different. The diagnosis of angioma was not suspected, either from the cystoscopic appearance or from inspection of the gross

specimen when removed. The left ureteral orifice was elevated by the tumor but showed normal squirts of indigo carmine; the right ureteral opening was normal.

Operation. Through a transverse suprapubic incision, the peritoneum was separated from the bladder and the vesical wall was incised. In shape and size the growth and its short pedicle greatly resembled a door knob. After excision, the bladder was closed and drained in the usual manner. The patient made an uneventful recovery and has had no return of bleeding or painful symptoms. The pain and fullness in the left kidney region did not reappear after the operation. He has agreed to return from time to time for cystoscopic observation and fulguration, if required for recurrences. The pathologist reported the tumor to be cavernous hemangioma.

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* Continued from page 368.

INSULIN IN OBLITERATIVE LESIONS OF THE BLOOD VESSELS*

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SINCE the isolation of insulin by Banting and Best in 1921 its uses as a regulator of carbohydrate metabolism, especially in diabetes and as a stimulator of certain nutritive processes, have been well established. Mothersill states that evidence is accumulating to show that insulin, or one of its component parts, is antagonistic to epinephrin, which is a constrictor of certain arterioles; in other words it is a vasodilator.

Some of the cases I have to report seem to raise the question as to whether these three activities of insulin adequately explain the results obtained. I would suggest that the property of fat consumption also operates.

My opportunities have been confined entirely to general country practice. During the past three years it has been my good fortune to see several cases presenting unusual features and each giving a hint for the use of insulin in new fields. I have no desire and am not qualified to argue pathology; but I would simply suggest a theory based on two accepted facts, which to me explains with some satisfaction the following cases. Stated first are the two facts, then the theory, followed by case reports.

1. Virchow proved many years ago that fat occurs in the intima of arterioles in sclerotic conditions. And Mallory, in his last work on "Pathologic Histology," states:

The presence of fat in the different cells forming the walls of blood vessels is the best guide we have as evidence that the functional activity of the lining is interfered with, owing to injury of some sort or other. If later the cells undergo necrosis the fat is set free and becomes a prominent feature in the lesions

formed because *its removal requires much time*. In fact the reaction to the fat, at least in the intima, forms the most conspicuous feature

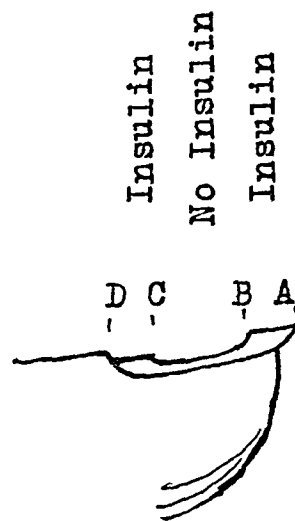


FIG. 1. A-B. Portion of nail grown while insulin was first taken. B-C. Nail growth during absence of insulin treatment. C-D. Nail growth since July, 1931, when use of insulin was resumed.

in many lesions, especially those of a chronic type. Under toxic and other unfavorable conditions fat may collect in the lining endothelial cells, in the muscle cells, or in the fibroblasts. Fat is also commonly associated with the more serious lesions of blood vessels, such as the hyaline change often present in the arteries of the spleen in diphtheria for example, and necrosis from various causes.

Joslin, in the chapter on Arteriosclerosis of his treatise, "Treatment of Diabetes Mellitus," discusses blood fat and cholesterol as a cause. He notes that fat in the form of cholesterol esters is deposited in the vessel walls by imbibition from the blood, these walls having no means of absorption, and that the more fat in the blood the more readily it would be deposited.

* Submitted for publication December 18, 1931.

Note: What a list of maladies this brief reference suggests: arteriosclerotic disease of the brain, the eye, the kidney, the aorta, the extremities, and how many others?

2. The second accepted fact is one established a few years ago: that insulin burns some fat in the "flame of carbohydrate combustion."

Serious consequences arise in a number of diseases because fat-laden cells gradually narrow and finally occlude completely the terminal vessels, as in atherosclerotic gangrene whether diabetic or not, in angina pectoris, in chronic nephritis.

The theory suggested is that insulin, given to a patient with any malady in which the terminal vessels are becoming occluded, in addition to digesting carbohydrates, stimulating nutrition, and dilating certain arterioles, may furnish relief by the burning of fat-laden cells in the flame which consumes blood sugar, thus allowing the blood stream to flow where it was stagnant or arrested.

Little can be expected of insulin in dealing with fibrous tissue or calcareous deposits. If a vessel lumen is gradually narrowed by a degenerative process the scar tissue and the calcareous deposits are only very slowly affected by any treatment. It is only the final plugging of the already almost completely obliterated vessel by fat-laden or degenerated cells that concerns us here. The only contention is that a very small lumen may be opened or maintained when, without insulin, no continuance of function could be possible. If insulin be used before stasis occurs much more may be expected.

I have seen insulin apparently help the following conditions:

1. Atherosclerosis, in both diabetics and non-diabetics.
2. Angina pectoris.
3. Bed sores in old people.
4. Deep and extensive leg ulcers.
5. Chronic nephritis.
6. Thromboangiitis obliterans.

These cases form a group in which terminal vessels are involved, with fat

occupying a prominent place in the pathology. If the theory has a reasonable foundation no apology is needed for presenting so diversified a list of reports.

CASE REPORTS

CASE I. *Diabetes with Atherosclerosis.* J. H., male, aged sixty-three, laborer.

This patient lost his right leg above the knee by amputation on account of gangrene which started in the great toe.

In September, 1928, Mr. H. had an infected ingrowing nail of the left great toe. The nail was very thin, the nutrition was defective. The infected area about the nail was a dirty gray color, gangrene threatened. Insulin was being administered three times daily. Weeks were required to secure healing, and when it was complete, it was noted that the new nail above the matrix, which had grown while the insulin was being given, was better nourished. It was thicker, whiter and flatter than the previous growth.

Just here I got my impression that the insulin affected the nutrition of the nail profoundly in addition to digesting carbohydrates. The improved growth of the nail was an index to the improved circulation of the whole foot and body. (This was three years ago.)

After several months, diet alone controlled the glycosuria and the insulin was omitted; but when, in July, 1931, the importance of insulin in maintaining nutrition in non-diabetic atherosclerotics was impressed on me by Case III, I prescribed a small dose for Mr. H. to be taken twice each week.

At the present time the record of the insulin on the growth of the nail is very clearly indicated, as shown in the accompanying sketch (Fig. 1).

During the absence of insulin the nail is thinner and contracted.

CASE II. *Diabetic Gangrene Right Foot.* Miss C. N., aged seventy-seven.

When gangrenous area appeared in dorsum and plantar surfaces of foot, it was found that this patient was a diabetic.

Insulin was prescribed and the diet regulated. Four months passed before the foot healed; and by that time the same trophic change was noted in the nails that had characterized the first case.

Diet alone controls the glycosuria, but the patient receives a dose of 5 units of insulin

once weekly in an effort to maintain the function of a damaged peripheral circulation.

CASE III. *Non-diabetic Threatened Gangrene Atherosclerosis.* M. V. S., male, aged sixty-three, fisherman. In November, 1930, the right foot was purple and swollen with complete stasis of the circulation.

On account of impressions received from Cases I and II, it was decided to see what insulin would do in this non-diabetic. Ten units were given; the foot was elevated and kept warm. Within twenty-four hours the swelling was gone and the foot was pink. Subsequent treatment consisted of 5 units of insulin given once per week.

The improvement in the growth of the toenails in this case has been more marked than in the diabetics.

As this paper is being prepared, this patient has been returned to the hospital for the removal of two bones of the great toe instead of the leg above the knee as was advised a year ago. At operation, three ligatures were required to control bleeding, and there was also free capillary oozing from the cut surface. On account of the abundance of blood supply to the soft parts, the wound was closed with stitches instead of being left open to granulate.

CASE IV. *Angina Pectoris.* Miss M. C., aged seventy-seven.

Non-diabetic. Cardiac hypertrophy. Three valves involved in chronic endocarditis.

The first attack of angina occurred in 1925; the second a year later; succeeding attacks becoming more frequent and severe. During the past year this patient moved only with pain, and required assistance dressing, retiring and rising.

For three years preceding June, 1931, this patient received treatment with iodides and nitrites, of the latter taking as many as twelve in a day. On June 29, 1931, a severe attack of angina required a hypodermic of morphia. (Comment: It was in the presence of this apparent calamity that the similarity of the pathology of the vascular system of the heart in angina to the pathology of the purple feet in threatened gangrene presented itself; insulin seemed to ask for a trial.) Beginning with a dose of 5 units of insulin, a total of 40 units was given over a period of a month, no dose exceeding 8 units. Orange juice or sugar followed one-half hour after each dose.

At the end of this period the patient was walking about at will, without assistance. The relief from pain is marked.

Note: In treating angina with insulin it must be borne in mind that the path to travel is very narrow; Joslin reminds us of the danger of a hypoglycemia to a weak heart muscle. One must be sure that the blood sugar level is sufficiently high. From experience with cases of precordial pain in the aged, in which the myocardium was involved and which were relieved entirely by doses of iletin as small as 3 units, I believe the doses of 8, or even 5, in the case here cited was unnecessarily large.

It should not be expected that insulin will relieve an acute attack of angina; but, given once or twice per week, it has been my experience that the attacks will be prevented.

CASE V. *Bed Sores in the Aged.* T. P. S., male, aged eighty-seven, veteran of Civil War. As a result of a fall on June 12, the neck of the left femur was fractured. On account of atherosclerosis and long confinement in bed and a lack of cooperation on the part of the patient in relieving pressure, a gangrenous area developed at the heel and along the outer aspect of the left foot. The heel area of gangrene was $1\frac{1}{4}$ inches long and $1\frac{1}{4}$ inches wide; around this and extending outward was a pink area of lowered resistance and slowed circulation.

On September 21, 5 units of insulin were given. Within forty-eight hours the pink discoloration was gone and was replaced by normal-looking skin. A second dose of 5 units was given on the twenty-third. On October 1 the entire gangrenous slough had separated, leaving a healthy granulating surface. On October 16, 5 units were again given, at this time the granulating surface had healed to the size of a dime; and on October 25 there was a tiny red spot remaining. Since insulin has been used no attempt has been made to relieve pressure, but healing has gone on as in a young healthy person.

It should be stated that during the last six weeks the patient has been out of bed several hours each day, thus relieving pressure.

CASE VI. *Deep and Extensive Leg Ulcers.* J. H. K., male, aged fifty-one, farmer. After a slight injury, an ulcer appeared on the calf of the right leg, in August, 1929. Septicemia developed in November of the same year. He was unable to walk for nine weeks, or to put his foot to the floor. June 1, 1931, the right leg was swollen to twice its normal size. It was discolored and the superficial layer of skin was moist and rubbed off with slight friction, leaving a red, oozing surface. In the calf of the leg was a deep crater-like ulcer measuring 6 inches across, and covered with a layer of gray granulations. No progress has been made toward healing since a serious illness in 1929.

Insulin was begun on June 1, 1931, and given once per week in a dose of 5 units. Beginning October 20, 5 units were given daily.

October 26, the size of the leg was normal. The granulating surface was level with the surrounding skin, and a strip of epithelium had grown entirely across the original area leaving two healing surfaces, each less than a half-dollar in size.

CASE VII. *Chronic Nephritis.* Mrs. M. G., aged thirty-two, white, housewife. This patient had mumps in early childhood; typhoid fever at six. There have been four pregnancies: the first normal with normal delivery in September, 1921; the second was terminated by cesarian section at seven months on account of bleeding from partially detached placenta, the cause not determined; the third was a normal pregnancy and delivery with good recovery; the fourth was terminated by curettage on account of the present condition of nephritis at six weeks.

After the third pregnancy the patient's health was good. When nephritis developed cannot be determined. It was discovered at an examination made March 11, 1930, at which time the symptoms would indicate that it had been present for some time. The chief complaint was of headaches; the blood pressure was 148/108.

There was double parotitis. Amount of urine: 2000 c.c. per day; light in color, clear, sp. gr. 1.012; acid; a dense cloud of albumin when boiled; no sugar. Microscopically much epithelium from whole urinary tract; clumps of amorphous urates; coarse granular casts and an occasional hyalin cast.

The parotitis yielded shortly to Basham's mixture. The headaches persisted and occurred

at shorter intervals in spite of diet regulation, which for a year has been limited to milk.

October 17, 1931: For several months the patient says she has had severe headaches at the vertex, averaging three per week and lasting about eighteen hours. On this date the headache was more severe than usual. The patient's color was poor, pale and gray; the eyelids were edematous.

Five units of insulin were given in the late afternoon. The patient says the headache was gone in less than two hours. There was no recurrence up to October 25. A second dose had been given on the twentieth, and it is proposed to repeat this once or twice weekly as indicated.

Examination of the urine shows a diminished amount of albumin. The same total quantity was passed in twenty-four hours.

December 1, 1931: Since October 25th the patient has appeared once in seven to nine days for her insulin. She has been free from headaches and her general appearance is improved.

Comment: Here we have a sclerotic terminal blood vessel condition similar to that in threatened gangrene and apparently a similar effect is produced by the iletin in both conditions: an improved blood supply to the part affected with improved function and diminished toxemia.

CASE VIII. *Buerger's Disease: Thromboangiitis Obliterans.* In order to readily understand this case it may be stated that early in July, 1931, after observing the case of angina, a paper discussing the first four cases was prepared and read at the July meeting of the Staff of the Cape Cod Hospital. Copies of this paper were sent to a medical journal and to certain individuals high in the medical profession. One copy was forwarded to Prof. E. J. G. B.; the latter on September 1, 1931, advised as follows:

"Dr. Beale: Today I have heard from the patient with Buerger's disease for whom you were kind enough to suggest insulin. I enclose the letter of his physician, Dr. E. A. B." This letter, which follows, furnishes the record of Case VIII, Mr. H.

"I have waited for results to reply to your very kind letter of July 22nd, suggesting the use of insulin in H's case.

"At the time your letter was received he was becoming rather desperate, running a temperature of 103.5 (ax) and with distended abdomen and delirium; all I could think of was internal gangrene and death. I immediately began the use of insulin continuing K. I. and M. S. (reducing the latter to $\frac{1}{8}$ A.M. and $\frac{1}{4}$ P.M.) and he began promptly to improve and is still improving.

"His mind has entirely cleared, temperature continues normal, pain lessened and occasionally he walks down stairs to a meal. Of course he has lost considerably in weight. There is less postural discoloration of both hands and feet which was becoming more and more marked. He has his days of depression but in general his mental attitude is very good. He has recently developed a mitral murmur, but all in all he is an entirely changed man since insulin has been given.

"We are grateful to you for the suggestion which was so timely and so helpful . . ."
F. B. A., M.D., August 31, 1931.

I wish to add here the following comment from one of the profession of high standing:

Anything that *may* work is well worthy of trial in these most painful and crippling disorders and if they relieve pain to any degree

we have, I think, no right to deprive a patient of that amount of relief even if we have no very good reason for thinking that we know *how* the good is done.

A further report from this case of Buerger's disease states that the torturing pain common in the later stages of this disease has appeared. If the pathology of this stage is borne in mind, the stage in which nerve, vein and artery and adjacent tissues are bound together and compressed by contracting scar tissue, little can be expected of insulin. It will be interesting to find what may be done if early diagnosis is made and insulin given from the outset.

Since submitting this article we have had 2 cases of acute obliterative enderitis at the Cape Cod Hospital in which the curative effect of insulin was demonstrated. Working with Dr. Elmer Robbins, Jr., we have secured very definite curative results with insulin in a case of chronic glaucoma complicated by chronic iritis. A case of vertigo in an elderly man, which I believe was due to sclerosis of the vessels of the middle ear, has remained free from symptoms for eight months following treatment with small doses of insulin.



A SIMPLIFIED POSTOPERATIVE ROUTINE FOR THE DIABETIC PATIENT*

J. THORNWELL WITHERSPOON, M.D.

NEW ORLEANS, LA.

DIABETES mellitus is a disease which, after passing through several medical phases, now has added a surgical aspect to its field of activity. Prior to the discovery of insulin it almost invariably terminated fatally, death being usually caused by diabetic coma. Now insulin tends to prevent acidosis, which is the initial stage of coma, and it is the sequelae of diabetes, or rather the associated pathologic conditions, which are causing death in the diabetic patient, chiefly arteriosclerosis, with its harmful effects on the cardiovascular-renal system, and gangrene of the extremities, with the possibility of septicemia. The pathology of the cardiovascular-renal system is still a purely medical consideration, but the beginning gangrene of the extremities, the slow, progressive ulceration of the toe or foot, have come under the care of the surgeon. These facts are fully comprehended, and an increasingly large number of diabetic patients are being cared for on surgical services today, but only a few surgeons have taken the time or made the effort to train themselves to care for the diabetic patient in any but his surgical aspect; their first appeal is for an internist to treat the diabetes, while they concern themselves only with the necessary surgery.

That the surgery of diabetes has a dual aspect is a fact that permits of no argument, and Joslin, in particular, has well stated the importance of the relation between the medical and surgical sides. Unless the diabetes is fully controlled before any surgery is undertaken, the patient is exposed to the risk of a stormy convalescence and to the possibility of an aggravation of his diabetes, since

insulin materially loses its effectiveness in the presence of infection. On the other hand, more than one writer has emphasized the fact that diabetes can actually become an asset to a patient because of the critical and painstaking care he receives preoperatively and postoperatively. In addition, as Saunders of Cornell has recently pointed out, the well cared for diabetic is seldom a candidate for surgery as a direct sequel of his disease: a hundred public ward patients require emergency surgery to every one private patient, a situation which furnishes convincing evidence of the value of proper medical care.

The usual method of handling the surgical diabetic is to provide him with separate medical and surgical care, but this dual method of therapeutics has many obvious disadvantages. It by no means follows that because a patient is receiving twice the amount of care, he is receiving twice as effective care; as a matter of fact, he is often receiving less effective care because of the divided responsibility. The internist usually prescribes entirely for the control of the diabetes, and perhaps never sees the surgical lesion postoperatively, or, if he does see it, does not recognize its full importance. On the other hand, the surgeon usually takes it for granted that the diabetes is well under control, and regards only the local lesion as his responsibility. Perfect cooperation would obviate these mischances, it is quite true, but perfect cooperation is frequently an ideal, not a fact, and with the best will in the world on the parts of all concerned, it is often not achieved. Would it not be simpler, therefore, especially on a large surgical ward, to have a routine standing treatment for all surgical diabetics, drawn

* Submitted for publication October 13, 1931.

up by the internist and supervised by him, but carried out by the surgical house staff under the direction of the surgical attendant? With such a plan in effect, the surgeon is able to judge more accurately the relation of the diabetes to the surgical wound, as well as the effect of the local disease upon the diabetes.

A routine of this kind has been in operation for a considerable period of time on Surgical Division A of St. Luke's Hospital in New York City, and I venture to present it here because my experience with it as Surgical House Officer at that institution convinced me of its safety and its practical advantages. The routine was devised by Dr. James R. Scott, Associate Attending Physician at St. Luke's, and I take this opportunity of acknowledging my indebtedness to him for the patient and painstaking instruction which he gave me in this method of treatment.

The preoperative control of the diabetes is, of course, a purely medical matter and is handled on the medical ward. The criteria of safety for surgery are a normal blood sugar for several consecutive days (three to six) prior to operation, and an immediate preoperative urine free from sugar, acetone or diacetic acid. The patient is transferred to the surgical service the evening before operation, and the routine of preparation differs from the usual routine in just one respect: two hours before operation the diabetic patient is given 6 oz. of orange juice by mouth and 10 units of insulin by hypodermic, this being a ratio of 1 unit of insulin to every 1.8 gm. of carbohydrate.

Operation can usually be done under gas and oxygen anesthesia, supplemented by a preliminary hypodermic of morphine. Ether is to be avoided because the diabetic does not tolerate it well.

The postoperative orders differ from the usual orders only in two respects, that the urine is examined at regular intervals, and that a special diet is instituted. The urine is examined at three-hour intervals for sugar, acetone and diacetic acid, even

if the patient has to be catheterized to secure the specimen. Five cubic centimeters of Benedict's solution are boiled for five minutes, preferably in a water bath, with 8 drops of urine, and the resulting specimen is checked against the table given below, insulin being administered according to the findings.

Color of Urine	Per Cent Sugar in Urine	Units Insulin
Blue...	0	Orange juice 6 oz.
Green.	Less than 1	5 units
Orange	1 to 5	10 units
Red .	5 to 10	15 units

The color scale is posted in a conspicuous place in the laboratory, and is made from ordinary crayons. The colors are taken from the colors obtained by boiling 1, 5 and 10 per cent glucose solutions with 5 c.c. of the Benedict reagent, and the order, naturally, is similar to the order in the spectrum. This color test, simple as it is, is perfectly accurate, for the colors have been checked and are within the range of the corresponding sugar percentages, and it can therefore be safely substituted for the more complicated sugar quantitative analyses; it is checked at intervals, of course, by blood sugar estimations. Moreover, it is practically error-proof for the administration of insulin.

Until the patient is able to eat a semi-soft diet, which is usually at the evening meal on the first day, nourishment must be given in the form of sugar, best administered orally as orange juice. If nausea is a feature, 6 oz. of a 10 per cent glucose solution can be given rectally, and if oral and rectal feedings are both impossible, intravenous glucose therapy can be resorted to. As a rule, however, the oral administration of orange juice is possible, and by the evening meal on the first day the patient can be given test diet No. 1, as shown on the diet card which is appended.

Unless the diabetes is shown by repeated urinalyses to be under absolute control, the three-hour urine examinations are continued throughout the first night, with the exception of the three A.M. test, which may be omitted if the patient must be awakened to secure the specimen. A specimen of blood is taken on the second morning for a sugar estimation. By this time the patient's condition is usually such that the test diet No. 1 can be divided into three meals a day, and the urinalyses can be reduced to four daily, one specimen being taken over night and one after each meal. Subsequently the blood sugar estimations need be made only every second or third day. Gradually the diet can be built up to one of the maintenance diets or to the diet given previous to operation, insulin being administered as necessary to keep the blood sugar normal and the urine sugar-free.

In the occasional case in which the urinalyses during the first twenty-four hours show that the patient has a tendency to acidosis and in which the blood sugar continues irregular, an emergency diet may be resorted to: orange juice and buttermilk, 6 oz. each, are given alternately every two hours for a total of eight feedings. This diet approximates 600 calories daily, and since it is palatable to the majority of patients, it can be continued over four or five days if necessary. The three-hour urine specimens must also be continued over this period, and blood sugar estimations must be made daily. When the diabetes is controlled, the patient can be put on test diet No. 1, and subsequently on one of the regular maintenance diets.

In any case in which the diabetes is not absolutely controlled postoperatively, prompt consultation is had with the internist who makes daily ward rounds in a supervisory capacity. Our experience at St. Luke's, however, is that such consultations are rarely indicated, for the reason

that the frequent checks upon the patient's condition make the control of his diabetes a relatively simple matter and prevent the development of unforeseen complications.

Personally, after my service as house officer on a surgical ward in which this routine was followed rigidly, I am convinced of the many advantages it offers. It requires no elaborate laboratory equipment, and so it can be used quite as well by the patient himself in his home after discharge as by the staff in the hospital. It is absolutely safe, because the three-hour urinalyses and the frequent blood sugar estimations ensure at all times full knowledge of the patient's condition. It provides for the individualization of each patient, because both diet and insulin are regulated according to his individual needs, as shown by accurate laboratory findings, and are not administered according to a fixed scale. It substitutes for the usual rather cumbersome dual control of surgeon and internist a single control which is particularly valuable when an emergency arises and special treatment is demanded without delay. And finally, as I have already pointed out, its success is proved beyond question by the results which have followed its employment on a large surgical service, and which have been almost invariably good.

Note. An illustration of the special sheet used for diabetic cases, which sets forth the progress of an uncomplicated test case, is herewith appended, as is one of the St. Luke's diet cards. Both the special sheet and the diet card will be found very convenient and helpful.

ROUTINE DIABETIC DIETS

St. Luke's Hospital

1931

"B. & O." diet*.....	C 122	P 21	F 7	Calories 635
Test diet #1.....	C 130	P 65	F 30	Calories 1050
Maintenance diet #1.	C 140	P 70	F 50	Calories 1290
Maintenance diet #2.	C 150	P 75	F 110	Calories 1890
Maintenance diet #3.	C 170	P 85	F 125	Calories 2145
Maintenance diet #4.	C 200	P 90	F 125	Calories 2510

ST. LUKE'S HOSPITAL
New York CityWard _____
Name _____

Age _____

Date	Urine 24 Hrs., Cc.	Total Output Fluid	Fluid Intake Mouth	Total Fluid Intake	HT. WT.	Food				Urine					Blood			Miscellaneous				Urine Microscopic Remarks				
						COH	Prot.	Fat	Total Calories	Sp. Gr.	Reaction	Alb.	Ferric Chloride	Nitro- Prusside	Sugar %	Color	Sugar	Urea	CO ₂ Vol. %	Total N	N of Food		Glucose Available	Glucose Utilized	Units Iletin	
1/1	6 A.M.	Mainten	ance	diet	170	85	125	2145	...	...	...	...	o	o	o	Blue	188	14.8	52	...	...	...	...	...	20 units 1/1	
	9 A.M.	..	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...		10
	1 P.M.	..	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...		10
	7 P.M.	..	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...		10
1/2	6 A.M.	..	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...	45 units 1/2	
	7 A.M.	..	..	..	..	6 3/4	Orange	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...		10
	9 A.M.	Operation	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...		10
	Noon	..	..	..	..	6 3/4	Orange	...	...	...	...	...	+	+	+	Blue	...	...	..	...	...	...	...	...		10
	3 P.M.	..	..	..	..	..	..	..	..	..	..	...	+	+	3%	Orange	...	...	..	...	...	...	...	...		10
	6 P.M.	Supper	Test	Diet	130	65	30	1050	...	...	...	...	+	+	2%	Orange	...	...	...	...	...	...	...	...		10
	9 P.M.	..	..	..	..	..	..	..	..	..	..	...	o	+	0.8%	Green	...	...	..	...	...	...	...	...	5	
	Midnight	..	..	..	..	6 3/4	Orange	...	...	...	...	...	o	o	o	Blue	...	...	..	...	...	...	...	...	15 units 1/3	
1/3	6 A.M.	Breakfast	..	..	..	..	..	..	..	..	..	...	o	+	o	Blue	164	15	46	...	...	...	...	...		10
	9 A.M.	..	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...		10
	Noon	Lunch	..	..	..	..	..	..	..	..	..	...	..	..	..	...	...	...	..	...	...	...	...	...		10
	1 P.M.	..	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...		10
	6 P.M.	Supper	..	..	..	..	..	..	..	..	..	...	..	..	..	...	...	...	..	...	...	...	...	...		5
	7 P.M.	..	..	..	..	..	..	..	..	..	..	...	o	o	o	Blue	...	...	..	...	...	...	...	...	Adjust insulin to diet.	
1/4	6 A.M.	Mainten	ance	Diet	170	85	125	2145	...	...	...	...	o	o	o	Blue	170	14.4	54	...	...	...	...	...		10



METASTATIC PULMONARY CARCINOMA*

ROBERT C. PENDERGRASS, M.D.

AMERICUS, GA.

IN every case of carcinoma the dread specter of metastasis haunts us. The early recognition of the spread of

In carcinoma of the breast, the chief sites of metastasis are lymphatics, skin, bones and lungs. Metastasis may occur



FIG. 1. Case 1. Infiltrative and massive types of metastases. Note circular area of calcification over right breast, shown by breast films to be in breast tumor.

cancer may prevent futile operations, enable us to alleviate suffering and prolong life, and give us a more accurate basis for prognosis, that thing about which we tell the family much and the cancer patient little. It is the object of this paper to call attention to one phase of metastasis, namely, lung involvement, and to illustrate the roentgen findings in this condition. The discussion will be limited to carcinomatous metastases of the lungs, and will deal more particularly with metastases from carcinoma of the breast.

* From The Wise, Smith and Anderson Clinic. Read before The Medical Association of Georgia, May 15, 1931.



FIG. 2. Case 11. Combined nodular and infiltrative types. More nodules on left, more infiltration on right.

elsewhere, but less frequently. As a rule, those cases showing lung metastases do not show bone metastases, and vice versa, but we will present an exception to this rule. Among other primary carcinomas which metastasize to the lung are those of the thyroid, adrenals, prostate, testicle, and rarely the stomach, esophagus, and cervix.

CLINICAL SYMPTOMS AND FINDINGS

The clinical symptoms of metastatic pulmonary carcinoma are usually meager, indefinite and unreliable. Pain is probably the earliest suspicious symptom, and is

usually due to pleural involvement. Cough occurs fairly early. Fever may be absent or slight. Hemoptysis and dyspnea are

the signs of effusion due to other causes; they exhibit more tendency to shifting than purulent exudates.



FIG. 3. Case III. Pleural type of involvement, with some consolidation of left lower lobe. Film made after aspiration of large amount of fluid.



FIG. 4. Case IV. Pleural type of involvement. Inoperable carcinoma of left breast. Example of direct extension to same side as tumor.

usually late symptoms. Sweats may occur at any stage, usually late. If effusion occurs, then cough, pain and dyspnea are apt to appear early; in large effusions, dysphagia is common, due to pressure on the esophagus.

The physical findings are extremely variable, and depend on whether the hilum glands, parenchyma or pleura is involved. Since more than one type of involvement often occurs in the same chest, we may get râles, dullness, signs of consolidation or of atelectasis, evidence of pleural pathology, tracheal deviation, or signs of effusion. If the miliary and small nodular metastases are present, there may be little variation from the normal; a counterpart of the paucity of physical signs in some cases of miliary tuberculosis. In the infiltrative, consolidation and atelectatic types, more change in breath sounds occurs. The signs of effusion are no different from

ROENTGENOLOGIC DIAGNOSIS

Since the physical findings in pulmonary metastasis are so highly variable, and smack more of confusion than of clarity, it is necessary to evoke the aid of radiology in diagnosis. Every case of primary malignancy elsewhere should be subjected to x-ray examination of the chest, for only in this way can lung involvement be detected early and depicted accurately. I do not wish to leave the impression that there is no room for error in the interpretation of the radiographs; this is far from true, but radiography offers the most efficient diagnostic method.²

Since x-ray shadows are based on pathological changes in the tissues, the classification of metastases from a radiological standpoint follows closely that of the pathologic classification and according to

Farrell¹ may be grouped under the following heads:

1. Metastases to the tracheobronchial

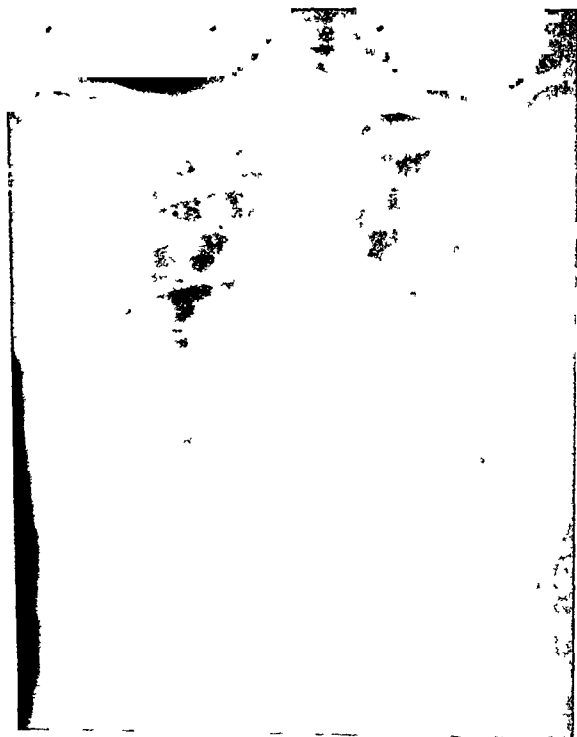


FIG. 5. Case v Large nodular metastases from carcinoma of cervix.

lymph nodes, appearing at the hilum and in the upper mediastinum.

2. Parenchymal metastases, of four types:

(a) Nodular: small or large nodules, sharply defined, scattered throughout the lung, more prevalent in the lower half.

(b) Miliary: similar to the nodular, but the masses are smaller and more evenly distributed. They may be calcified (Hirsch).²

(c) Infiltrative: a radial increase in the markings arising at the lung root; these are prolonged into the parenchyma. Mottling may occur.

(d) Massive: consolidation of all or part of the lobe, and often associated with pleural changes.

The atelectasis of a lobe, due to bronchial obstruction by tumor nodules, should probably be included in this massive type.

3. A third classification (Sante), includes pleural thickening and pleural effusion.

In metastasis from carcinoma of the breast, we may see any or all of these forms. The nodular type of metastasis is most easily recognizable, but may be confused with sarcomatous metastases.³ The miliary type may be confused with miliary tuberculosis, but the masses in tuberculosis are usually smaller and less sharply defined; the higher pulse rate and temperature and positive sputum in tuberculosis serve to differentiate the two.³ The infiltrative and massive types are also common, usually associated, and may involve a goodly portion of both lungs. The atelectasis produced by nodules blocking the bronchi, if the atelectatic area is large, may produce distressing pulmonary symptoms, simulating pneumonia on casual examination.

Single large metastatic areas may be confused with primary tumors, as may also hilum lymphatic masses. This is particularly true of the rather uncommon fibroma of the lung, which is usually present as a single rounded mass.³

Pleural involvement may occur by direct extension along the lymphatics penetrating the chest wall on the same side as the breast lesion, or may reach the opposite side by a more devious route. In differentiating pleural thickening from effusion, the interspaces are usually narrowed instead of widened, and on diagnostic puncture the thickened pleura is felt, while no fluid is obtained. If effusion is present, the withdrawn fluid is usually blood-tinged. A tendency to rapid reaccumulation is nearly always shown. We have withdrawn a half gallon of such fluid from one side of the chest, only to withdraw the same amount a week later. Primary periosteal tuberculosis of the ribs, secondary sarcoma, and metastases from hypernephroma may resemble carcinomatous metastases of the pleural type. Pleural thickening may occur from the heat of the cautery used at operation or from heavy radiation.³

APPLICATION OF ROENTGEN FINDINGS

Once the diagnosis of pulmonary metastasis is established, what are we going to do about it? If a primary malignancy is already known to exist, we may direct treatment to it and to the lung metastases; if the pulmonary metastases are found first, we have received a tip as to the presence of primary malignancy elsewhere, and should search for it.

All types except the pleural effusion type should receive x-ray therapy of the chest; one may succeed in relieving pain and cough, and in prolonging life. Too vigorous treatment will make these patients sicker and perhaps shorten life. Partial erythema doses at fairly long intervals seem to have better effect than massive doses applied within a few days. In some cases the nodular masses will become smaller, and even disappear for a time.³

If effusion is present, repeated withdrawal of the fluid is perhaps the only method of treatment. Reinjection of equal amounts of air, as suggested recently by Dana⁴ in the treatment of empyema may be of benefit. We have used this method in one case. Very little shock or coughing occurs when this method is used. The temporary relief from pain and dyspnea afforded these patients is ample reward for our labors, and compensation for our disappointments in others.

The chief value of the detection of pulmonary metastases is akin to that of the detection of bone metastases, the prevention of futile operations. It may determine whether we shall employ surgery with radiation or radiation alone. Every case of primary carcinoma capable of metastasizing to the lungs should have an x-ray examination of the chest before operation.

The general practitioner who has to care for the carcinoma patient after the surgeon and radiologist finish with him has on his shoulders the care and responsibility of the patient. It is he who maintains the lookout for metastasis. If, in

the intervals between periodic examinations by the operator or radiologist, the patient exhibits pain in the chest or a continued cough, x-ray examination of the chest should be made at once. These are the warning signs of pulmonary metastases just as pain is the warning sign of bone metastases. I believe that periodic x-ray examinations of the bones and lungs, after operation for carcinoma of the breast, will eventually come to be as much a routine as inspection of the operative scar and palpation of the neighboring lymphatics. As an illustration of the value of x-ray examinations, one of our cases had two tiny recurrences in the scar, and a lung full of metastatic nodules with very little cough or pain; another had extensive pulmonary metastases with no local recurrence. Everyone sees examples of this.

CASE REPORTS

CASE I. Referred by Dr. J. T. Stukes. Negress, aged thirty-three. Noticed lump in right breast about one year before coming to clinic. This had grown rapidly and was ulcerated. Large, inoperable cauliflower carcinoma of right breast. First seen February 27, 1929. Deep x-ray therapy begun then. Failed to return for treatment until June 2, 1930, at which time metastases found throughout both lungs. Persistent cough. Further therapy lessened cough and pain in chest. Died January 1931, two years after first visit and about three years after lump first noticed in breast.

CASE II. Referred by Dr. B. T. Wise. White female aged fifty. Amputation left breast, for scirrhus carcinoma, October 20, 1928. Postoperative radiation. Several small nodular recurrences in scar, treated by surgical removal and radiation. On January 3, 1931, complained of some cough and pain under left shoulder. Film showed numerous nodular and linear type metastases in both lungs. Pain and cough greatly relieved by therapy over chest at intervals. Now having pain in hips and back, but films show no metastases.

CASE III. Referred by Dr. E. B. Anderson. White female aged thirty-eight. Radical resection right breast, December 30, 1929. Pathological diagnosis: Scirrhus carcinoma. Postoperative therapy at intervals. In February

1931, acute respiratory attack resembling influenza. Large effusion left chest. Film after aspiration shows pleural thickening and some consolidation of lower lobe. Fluid reappeared after repeated withdrawals, 22 qts. in one month. Developed cerebral symptoms, with facial paresis, and died in coma after prolonged illness, on September 1, 1931.

CASE IV. Referred by Dr. Chas. A. Greer. Negress aged thirty-two, September 13, 1931. Large, inoperable carcinoma of left breast; involvement of axillary lymphatics. Physical signs of pleural involvement left breast. Film shows pleural thickening, left. Example of direct extension. Given deep x-ray therapy; moved, and have lost track of patient, though still living nine months after first seen.

CASE V. Referred by Dr. S. P. Wise. White female aged forty-five, November 28, 1930. First seen with complaint of pain in back and fever. Pyelogram right kidney showed only slight hydronephrosis. On this film was noted a metastatic lesion in the fourth lumbar vertebra, and metastases in lower lung fields. Chest film (Fig. 5) shows numerous large metastases. No pulmonary symptoms. Inquiry disclosed grade 3 carcinoma of cervix treated with

radium four years previously, and with no evidence of recurrence one year after treatment. Patient died July 1931, about five years after treatment of original lesion with radium and eight months after discovery of metastases.

SUMMARY AND COMMENT

1. Attention is drawn to the subject of carcinomatous metastases to the lungs, and to the unreliability of symptoms and physical signs in the diagnosis of this condition.
2. The pathology and the resultant roentgen findings are discussed.
3. The practical applications of the discovery of pulmonary metastases are stressed.
4. Brief reports of 5 cases, with radiographs, are given.
5. Every case of primary carcinoma, especially carcinoma of the breast, should have a roentgen examination of the chest and skeleton before operation, and periodically after operation.

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STUDIES ON THE EFFECTS OF
SUBTOTAL GASTRIC RESECTION IN THE DOG*

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CHICAGO

THIS study was undertaken to complete a series¹ of observations in dogs on the effect of various gastric resections in the main stomach, three weeks, a very short period, after a Polya type of resection of the antrum, but found free



FIG. 1 Jejunal ulcer that occurred in Dog 4. Stomach had hypertrophied to twice original size and jejunum opposite orifice had also hypertrophied to about the same extent. Dog died from hemorrhage from the ulcer at seven months and twenty days

operations on the physiology of the stomach and on the occurrence of postoperative jejunal ulcer. We were particularly interested in ascertaining the postoperative effects of the Finsterer² type of gastric resection in the dog.

Observations on the effect of gastric resection on gastric secretion in the dog have been made by Ivy and Whitlow,³ Smidt,⁴ Portis and Portis⁵ and Steinberg, Braugher and Vidgoff.⁶ Smidt found that resection of the pyloric antrum (Billroth I) decreased the chemical phase of gastric secretion in Pavlov pouch dogs. Portis and Portis found an absence of free acid



FIG. 2. Perforated jejunal ulcer in Dog 6. Finsterer type of operation is evident. Stomach remnant had hypertrophied some and jejunum at site of ulcer and just below had dilated and hypertrophied to a slight extent. Dog died of peritonitis at four months and twenty-three days

acid in the usual amount in the juice secreted by the Pavlov pouch, which was also found by Ivy and Whitlow. The findings of Steinberg and his associates were essentially confirmatory of those of Portis.

METHODS

The type of resection performed by us was very much like that employed

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by Finsterer in man. The portion of the stomach resected was from the pyloric sphincter to a line drawn from a point

of retrograde filling of the duodenum. The end of the duodenum at the pyloric sphincter was closed. The anastomosis



FIG. 3 Hypertrophied stomach of Dog 8 that died of inanition and pneumonia at three months and twenty days. Photograph reduced one-half. No ulcers were present. Defects in gastric and jejunal wall were made for purpose of microscopic study. Tissue was removed from six different areas and revealed presence of parietal cells throughout up to mucosa surrounding cardia. Jejunum was slightly dilated and circular layer of muscle was three times thicker than normal. Note that jejunal hypertrophy in this dog was confined to that portion opposite stoma. Stomach converted itself into Polya type of anastomosis.

on the lesser curvature 1 cm. proximal to the incisura angularis to a point opposite on the greater curvature. The portion resected amounted to approximately 66 per cent of the stomach. About 3 cm. of the gastric incision from the lesser curvature was closed with sutures and the remaining stoma was anastomosed to the side of the first loop of jejunum, stitches being taken to prevent angulation on the proximal side of the anastomosis in an attempt to reduce the likelihood

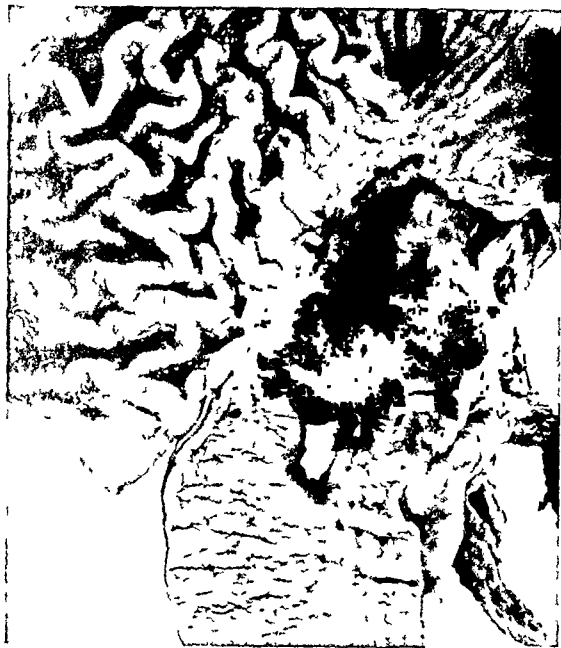


FIG. 4. Perforated jejunal ulcer in Dog 11, which died of peritonitis at five months and ten days. This dog's stomach had hypertrophied to its original size.

was made without placing clamps on the intestine. The dogs were fed a diet of cooked yellow corn meal, bread and bone soup with meat and milk. The weight and appetite of the animals were observed, and in those that lost weight, special attention was given to feeding. Gastric analyses were made at intervals of several weeks and samples were withdrawn two, three and four hours after the test meal of 250 gm. of "fox food" and 150 c.c. milk. The meal itself on titration yielded no free acidity and thirty-two clinical units of total acidity. The emptying time of the stomach was followed under the fluoroscope. At intervals the dogs were given all of the barium impregnated meat they would voluntarily eat and a tracing of the stomach on the fluoroscopic screen was made. In this way we could follow the "hypertrophy" of the stomach without resorting to the use of x-ray plates. All autopsies were done immediately or very soon after death.

RESULTS

Of 16 dogs operated upon, 12 lived more than three months. The 3 dogs that died, died at from one to two months of a low grade peritonitis. Table 1 shows the results of the operation very briefly, the incidence of the development of jejunal ulcer, the hypertrophy of the stomach and jejunum, and the gastric analysis and emptying time.

Nutrition: Of the 12 dogs, 5 (Dogs 1, 2, 5, 9, 12) remained in excellent condition throughout the period of observation. The other seven remained in good condition for periods varying from one to four months. The disturbed nutrition of 3 of the 7 (Dogs 4, 6, 11) was caused by the occurrence of a jejunal ulcer. In the other 4 (Dogs 3, 7, 8, 10) the disturbance of nutrition was due to inadequate digestion. Three of these 4 dogs had marked polyphagia and ate voraciously about twice the amount of food fed other dogs of the same weight. Large bulky stools were passed that contained much undigested material. The remaining dog (Dog 3) ate irregularly and slowly without much appetite. This dog acted after the first four months as if a jejunal ulcer had developed, but none was found at autopsy and the stools were not tarry.

Jejunal Ulcer: A jejunal ulcer occurred in 3 of the 12 dogs (Dogs 4, 6, 11) which caused death. In one other dog (Dog 9) a healed jejunal ulcer was found at autopsy. The jejunal ulcers as judged from our records of the behavior of the dogs developed from three to four months after the operation.

Hypertrophy and Dilatation of the Stomach and Jejunum: Hypertrophy and dilatation of the stomach occurred in 6 of the 12 dogs. The stomach returned to normal size in 4 and in the remaining 2 dogs no definite hypertrophy resulted. At autopsy we distinguished between hypertrophy and dilatation by the presence of rugae or folds of mucosa, the mucosa being in folds in all dogs. Fluoroscopic studies at

intervals revealed that the hypertrophy was quite evident at two months and was maximum at six months. Histological study showed that the hypertrophy was real. For example in Dog 8, in which at three months and twenty days the stomach at autopsy was twice the normal size (Fig. 3), the mucosa was in folds throughout and there was a definite area in the fundus along the greater curvature which was distinctly lighter in color and contained some cells in mitosis. Well-developed fundic glands with parietal cells were present throughout the gastric mucosa up to the cardiac mucosa. The wall of the jejunum opposite the stoma was almost three times thicker than normal, the hypertrophy involving chiefly the circular muscle layer. The jejunum was hypertrophied only in the dogs that manifested hypertrophy of the stomach.

Gastric Analyses: The control analyses of the gastric response to the test meal ranged maximally from 0 to 45 clinical units of free acidity and from 90 to 110 units of total acidity. The post-resection analyses, all of which are not given in Table 1, show that the acidity of the gastric contents returned about to normal (total acidity 70–110 units) in from three to five months. The two-hour acid values, except in the stomachs which failed to hypertrophy, were lower than normal.

Gastric Emptying Time: The control emptying time varied from four and one-quarter hours to five and one-quarter hours. After resection, the emptying time was reduced at the first observation made, about one month after the resection. The emptying time at three and six months postoperatively was reduced from one and one-half hours to two and one-quarter hours. It is significant that this reduction in emptying time occurred irrespective of the hypertrophy. The hypertrophied stomachs emptied the test meal as quickly as the stomachs that did not show hypertrophy.

"Polyphagia": The presence of an excessive desire to eat, which was satisfied

TABLE I

RESULTS ON GASTRIC ANALYSIS AND EMPTYING TIME OF STOMACH OF DOGS SUBJECTED TO SUBTOTAL GASTRECTOMY

Dog No.	Duration of Experiment	How Expt. was Terminated	Ulcer	Hypertrophy of Stomach & Jejunum	Gastric Acidity*	Gastric Emptying Time†
1	14 mo.	Killed. Excellent condition	None	To original size	1 mo. F.A.—0 T.A.—80 6 mo. F.A.—21 T.A.—75 10 mo. F.A.—60 T.A.—100	3 mo. 3' 15" 6 mo. 3' 00"
2	14 mo.	Killed. Excellent condition	None	To original size	1 mo. F.A.—0 T.A.—62 6 mo. F.A.—20 T.A.—90 10 mo. F.A.—20 T.A.—90	3 mo. 4' 15" 6 mo. 3' 00"
3	7 mo.	Death. Inanition. Good cond. for 4 mo.	None. Petechial hemorrhage in jej. opposite orifice	None	1 mo. F.A.—0 T.A.—60 6 mo. F.A.—15 T.A.—85 7 mo. F.A.—20 T.A.—72	3 mo. 3' 50" 6 mo. 3' 20"
4	7 mo. 20 days	Death. Anemia due to hemmor. of ulcer. Good cond. for 3 mo.	Jejunal ulcer, 1½ × ¾" almost perforated	Marked hypertrophy 2 × orig. size. Jejunum opposite orifice hypertrophied	2 mo. F.A.—0 T.A.—80 5 mo. F.A.—25 T.A.—85 6 mo. F.A.—20 T.A.—70	2 mo. 3' 15" 5 mo. 3' 00"
5	13 mo.	Killed. Excellent condition	None	Slight hypertrophy above normal	1 mo. F.A.—0 T.A.—70 5 mo. F.A.—3 T.A.—67 6 mo. F.A.—5 T.A.—80 10 mo. F.A.—10 T.A.—90	1 mo. 3' 00" 6 mo. 2' 40"
6	4 mo. 23 days	Died. Perforated ulcer. Good cond. 3 mo.	Jejunal ulcer just below anastomosis	Some hypertrophy but not to original size	1 mo. F.A.—0 T.A.—80 ?	1 mo. 4' 55" ?
7	4 mo. 16 days	Inanition. Good cond. for 2 mo.	None	Dilatation & hyper. 2 × original size. Some hypertrophy of jejunum	1 mo. F.A.—0 T.A.—65 4 mo. F.A.—18 T.A.—85	1 mo. 3' 30" 4 mo. 3' 00"
8	3 mo. 20 days	Died. Pneumonia, inanition. Good cond. for 1 mo.	None	Dilatation & hypertrophy 2 × normal size. Jej. hypertrophied	3 mo. F.A.—10 T.A.—72	1 mo. 3' 40" 3 mo. 3' 00"
9	11 mo.	Killed. Excellent condition.	Healed ulcer of jejunum peritoneal adhesions at site of ulcer.	Hypertrophy 2 × normal hyper. of jej. opposite orifice	3 mo. F.A.—0 T.A.—80 6 mo. F.A.—10 T.A.—110	3 mo. 3' 20" 6 mo. 3' 15"
10	6 mo. 21 days	Died. Distemper with peritonitis. Good cond. for 3 mo.	None	Stomach 2 × normal. Marked hyper. Some dilation & hyper. of jejunum	3 mo. F.A.—20 T.A.—65 6 mo. F.A.—50 T.A.—110	3 mo. 2' 30"
11	5 mo. 10 days	Died. Peritonitis. Good cond. for 3 mo.	Perforated jejunal ulcer just below anast.	To original size	3 mo. F.A.—0 T.A.—90 5 mo. F.A.—5 T.A.—84	3 mo. 3' 0"
12	4 mo. 10 days	Killed. Good condition	None	Dilatation & hypertrophy 2 × normal	None	None

* Highest value of a 4 hr. gastric analysis. F.A. stands for free acidity and T.A. for total acidity. Preoperative analyses ranged from 0-45 units for free acidity and from 100-110 for total acidity.

† The normal emptying time for the test meal used varied from four and one-half to five and one-fourth hours. The data given on the emptying time in the table is in hours and minutes.

in all dogs, appeared in 9 of the dogs (Dogs 1, 2, 4, 5, 7, 8, 9, 10 and 12). This we believe was due to a lack of proper digestion as is shown by the fact that these dogs passed bulky stools containing undigested food. This is also true of dogs which have had the pancreatic ducts successfully ligated.

DISCUSSION

The important point that this work demonstrates is that the stomach may undergo considerable hypertrophy after resection. In one-half of the dogs operated upon the stomach not only returned to normal size but became larger than normal. Definite hypertrophy occurred in 9 of the 12 dogs. As the stomach hypertrophied, the gastric acidity returned to normal and plenty of acid was found at three or four hours even in the stomachs that did not show much hypertrophy. We had expected to obtain some hypertrophy, but not so extensive as was found in some of the dogs. Hypertrophy and dilatation of the jejunum only occurred in those dogs that had a hypertrophied stomach. The clinical literature on the after-effects of gastrectomy say practically nothing concerning the hypertrophy of the stomach. Finsterer and Cunha² state that symptoms attributable to the reduced size of the stomach disappear after two or three months because the jejunal loop dilates and not because of increase in size of the stomach. This was not true for our dogs which may be due to the possibility that our dogs were less judicious in eating after the operation and less sensitive to distress caused by distention. Obviously if the stomach of man tends to hypertrophy in the same way as that of the dog does, there being little reason to doubt such a fundamental biological property, the question arises, why resect the stomach except for well-established surgical indications?⁷ It is quite obvious that if a patient with a subtotal gastrectomy can after a period of

several months eat three regular meals a day some hypertrophy must occur somewhere, even though the stomach does empty more rapidly than normal. It is doubtful whether the jejunum can hypertrophy to such an extent that it is able to provide the volume required for a regular meal. We are not convinced that hypertrophy of the stomach does not occur more frequently than reported in the literature, and believe that if proper studies with a bulky meal (not barium milk) impregnated with barium were made, more or less hypertrophy would be found in the majority of cases in man. Of course it must be granted, because of species difference, that the findings in the dog may be an exaggeration of what actually occurs in man, but the results on the dog indicate that further careful studies of the nature of those made by Klein⁸ on the acidity of the gastric contents following gastric resection must be made.

The very interesting and important question arises, namely, what is the cause of the hypertrophy? We at first assigned the cause of the hypertrophy to the jejunum. It is known that the duodenum and jejunum of some dogs and men are more susceptible to distention than others. It was therefore thought that in those dogs whose stomach hypertrophied, the jejunum was sensitive to distention and hence would contract when food was ingested, causing the food to be retained in the stomach, which resulted in "stretch hypertrophy." However, when we found that the emptying time of the stomach was reduced in all dogs, we were forced to give up this explanation at least in part. We next directed our attention to the factor of "polyphagia," or the rate at which the dogs ingested food and the amount of food ingested within a short period. We found that with but one exception (Dog 9) hypertrophy occurred in those dogs which rapidly ingested the food set before them. The dogs that manifested no hypertrophy of the stomach

ate slowly throughout the entire day and did not manifest hypertrophy. The exceptional dog (Dog 9) ate slowly. Apparently those dogs that ate slowly were distressed when they ate fast and refrained from so doing, which is exactly like the eating habits of dogs from which the entire stomach has been removed and the esophagus anastomosed with the duodenum.⁹ Hence, we believe that the most reasonable explanation of the hypertrophy that occurs in the gastric remnant is due to fast eating of large quantities of food that some dogs persist in doing in spite of the fact that within a week or so following the operation fast eating causes them to vomit.

The fact that jejunal ulcers were obtained in 3 of the 12 dogs, or 25 per cent, is not surprising in view of the return of gastric acidity to normal in from three to five months. Mann and Williamson¹⁰ obtained 100 per cent jejunal ulcers in dogs on anastomosing the end of the jejunum to the end of the stomach and diverting the alkaline juices to the ileum. Fauley and Ivy¹ confirmed the findings of Mann and Williamson, but only obtained 45 per cent of jejunal ulcers when a Polya gastrojejunostomy was done and the alkaline juices were diverted to the ileum, showing that the size of the orifice plays a role in determining the incidence of postoperative jejunal ulcer. In the dogs in this study in which the orifice was large and the alkaline juices were not diverted, we obtained an incidence of 25 per cent which is a somewhat higher incidence (5 to 10 per cent) than in dogs with a simple gastrojejunostomy. This is probably within the experimental error. This incidence of postoperative jejunal ulcer in the dog after subtotal gastric resection coincides with the incidence of jejunal ulcer following simple gastroenterostomy in man (4 to 30 per cent),^{7,11} but does not coincide with the incidence of jejunal ulcer following gastric resection in man reported by Finsterer and Cunha,¹ Berg¹² and Strauss and associates,¹³ in

which the incidence was about 1 per cent. However, it is probably too early to obtain accurate statistics, especially in view of the report of Hurst,¹⁴ who states that he has collected over one hundred cases of secondary ulcer following gastrectomy, and of Balfour¹⁵ who has operated on 28 cases of recurrent ulcer following gastrectomy. That they do occur is agreed to by practically every writer who has performed a number of subtotal gastrectomies.^{16,17} The advocates of gastrectomy state that in such cases "sufficient" stomach was not removed.

In view of the hypertrophy of the stomach that occurred in our dogs, it is not surprising that the acid values returned practically to normal. Some of our high values are undoubtedly due to the fact that the sample of gastric contents was removed at three or four hours when the stomach was about empty; but the dogs with a hypertrophied stomach after three to five months showed practically a normal acidity curve. This finding is not at variance with clinical findings,^{16,17} especially since Klein⁸ and Perman¹⁸ found free acid in the gastric contents of those gastrectomized patients who had high acid values prior to the operation.

Judging from the reports of some,^{1,12,13} however, the acidity of the gastric contents following "sufficient" gastric resection does not become adequate for the production of jejunal irritation and jejunal ulcer save in a small percentage of cases. The factors that are operating in an integrative manner are (a) the amount of stomach removed, (b) the amount of postoperative hypertrophy, (c) the rate of emptying of the stomach, (d) the amount of pancreatic juice and bile formed, which may be reduced when the food does not pass through the duodenum, (e) the amount of mixing of the alkaline juices in the stomach, and (f) the amount of inhibition of gastric secretion incident to reflexes from the distended jejunum, adhesions, and uncomfortable sensations following eating. In this connection Holinger, Kelley and Ivy¹⁹

have found that continuous jejunal alimentation in the dog markedly decreases gastric secretion for from one to two hours or longer after starting the feeding which is probably due to overdilatation and irritation of the jejunum. The intestinal phase of gastric secretion then begins to operate and gastric secretion is resumed. Thus, in a stomach that empties rapidly after gastric resection, this inhibitory factor would play a role in decreasing the gastric secretory response to a meal.

The decrease in the emptying time of the stomach observed by us is in accord with the clinical literature.^{13,20}

SUMMARY

Resection of at least 66 per cent of the stomach in 10 out of 12 dogs resulted in varying degrees of compensatory hypertrophy of the gastric remnant. It is believed that the hypertrophy was due to rapid eating of large quantities of food due to the polyphagia incident to inadequate digestion. The jejunum at the stoma was also hypertrophied. The emptying time of the stomach was permanently decreased in spite of the hypertrophy. The acidity of the gastric contents returned practically to normal in from three to five months. Jejunal ulcers developed in 3 of the 12 dogs.

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LOCAL SURGERY OF PAINFUL BACKS

WITH REPORT OF CASES*

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ETIOLOGY

IT is not the purpose of this paper to take up all the causes and treatments of pain in the back, but a short review of the subject with mention of the more common causes may be indicated. The etiology may be divided as shown in Table 1.

TABLE I
CAUSES OF BACK PAIN
A. LOCAL

- | | | |
|--|---|--|
| <p><i>I. Inflammation.</i></p> <p>1. Acute.</p> <p> *a. Boils and carbuncles.</p> <p> *b. Cellulitis.</p> <p> c. Myositis or lumbago.</p> <p> d. Of nervous system.</p> <p> (1) Neuritis & Neuralgia.</p> <p> (2) Anterior poliomyelitis.</p> <p> (3) Meningo-encephalitis.</p> <p> *c. Osteomyelitis.</p> <p> f. Arthritis.</p> <p> (1) Septic condition.</p> <p> (a) Tonsillitis.</p> <p> (b) Alveolar abscess.</p> <p> (2) Typhoid fever.</p> <p>2. Chronic.</p> <p> *a. Osteomyelitis.</p> <p> *b. Tuberculosis.</p> <p> c. Osteoarthritis.</p> <p> d. Syphilis.</p> <p> (1) Arthritis.</p> <p> (2) Gumma.</p> <p> (3) Charcot joint.</p> <p> *e. Anterior poliomyelitis.</p> | <p><i>II. Trauma.</i></p> <p>1. Contusions.</p> <p>2. Sprains.</p> <p>*3. Dislocation.</p> <p> *a. Spondylolisthesis.</p> <p>*4. Fractures.</p> <p> *a. Kummels.</p> <p> b. Body.</p> <p> c. Processes.</p> <p>*5. Combinations.</p> <p><i>III. Tumors.</i></p> <p>1. Benign.</p> <p> a. Lipoma.</p> <p> b. Fibroma.</p> <p> c. Osteoma.</p> <p>*d. Cord.</p> <p>2. Malignant.</p> <p> *a. Primary.</p> <p> (1) Cord.</p> <p> (2) Sarcoma.</p> <p> b. Secondary.</p> <p> (1) Carcinoma.</p> <p> (a) Thyroid.</p> <p> (b) Prostate.</p> <p> (c) Breast.</p> <p> (2) Hypernephroma.</p> | <p><i>IV. Congenital.</i></p> <p>1. Anomalies & Malformations.</p> <p> a. Absence of part.</p> <p> *b. Asymmetry.</p> <p>*2. Dislocations.</p> <p>*3. Postural or mechanical.</p> <p> a. Anomalies.</p> <p> (1) Acute angle 5th & 1st.</p> <p> (2) Lateral processes.</p> <p> (a) Irregular.</p> <p> (b) Asymmetrical.</p> <p> (3) Impinging spinous process</p> <p> (4) Defective closure.</p> <p> (5) Incomplete union.</p> <p> b. Incomplete sacralization.</p> <p> c. Failure of union arch & body.</p> <p> d. Posterior displacement 5th. L.</p> <p><i>V. General condition.</i></p> <p>1. Rickets.</p> <p>2. Pernicious anemia.</p> <p>3. Lateral sclerosis.</p> <p>4. Thyrotoxicosis.</p> <p>5. Pregnancy.</p> <p>6. Neuroses.</p> |
|--|---|--|
- B. REFERRED
1. Pelvic.
- *(1) Malpositions of uterus.
- *(2) Ovarian cyst.
11. Abdominal.
- *(1) Appendicitis.
- *(2) Cholecystitis.
111. Genitourinary.
- (1) Nephritis.
- (2) Pyelitis.
- *(3) Nephrolithiasis.
- iv. Disturbances of joints.
- (1) Hip.
- (2) Knee.
- (3) Foot.
- v. Thoracic.
- (1) Intercostal neuralgia.
- (2) Pleurisy.

* Operable cases.

* Read before the Evanston Branch of the Chicago Medical Society, March, 1931.

DIAGNOSIS

Naturally so varied a list of conditions causing back pain makes the diagnosis

ment other than surgery, and in most cases these treatments should be tried first. For certain acute inflammations the

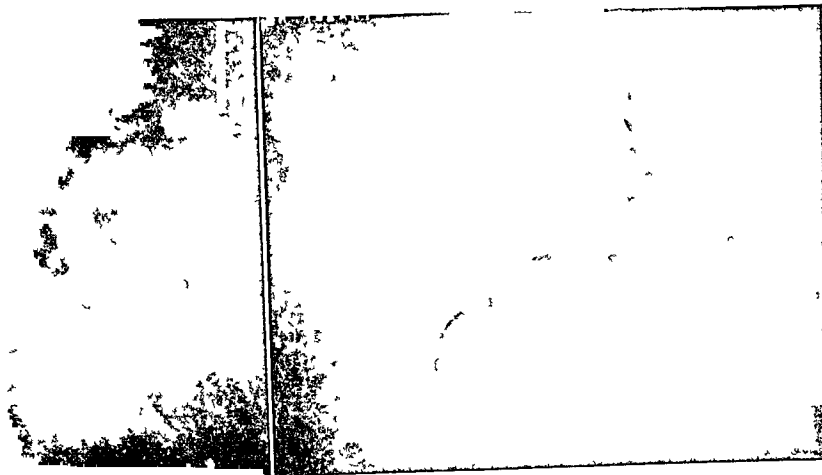


FIG. 1. Case 1. Lateral view.

FIG. 2. Case 1. Anteroposterior view.

sometimes very obscure, and the cure difficult. However, by making a careful and complete examination of each case, including history, physical examination, laboratory and x-ray findings, we are

obvious treatment is surgery: incision and drainage; boils, carbuncles, cellulitis and acute osteomyelitis, if diagnosed.

1. FIXATION OPERATION: Other conditions, usually more chronic, can be cured

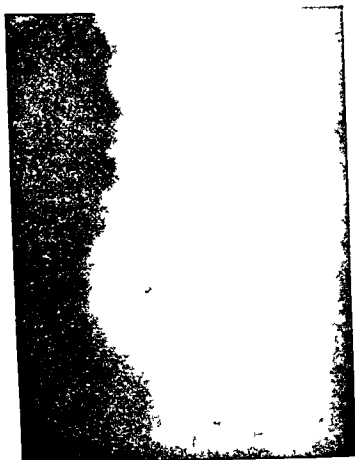


FIG. 3. Case 11. Spondylolisthesis. Lateral view.

usually able to arrive at the first, with hopes of obtaining the latter.

TREATMENT

Certain of these conditions then require relief at the source, medical, physiotherapeutic, orthopedic or manipulative treat-

or relieved by some sort of fixation operation. In these operations the attempt is made simply to help nature out by holding

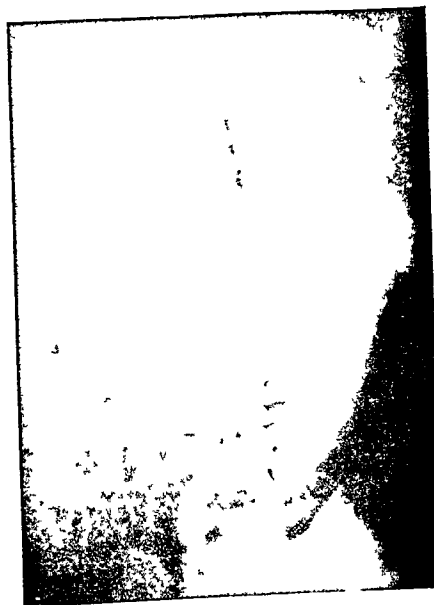


FIG. 4 Case 11. Spondylolisthesis Anteroposterior view.

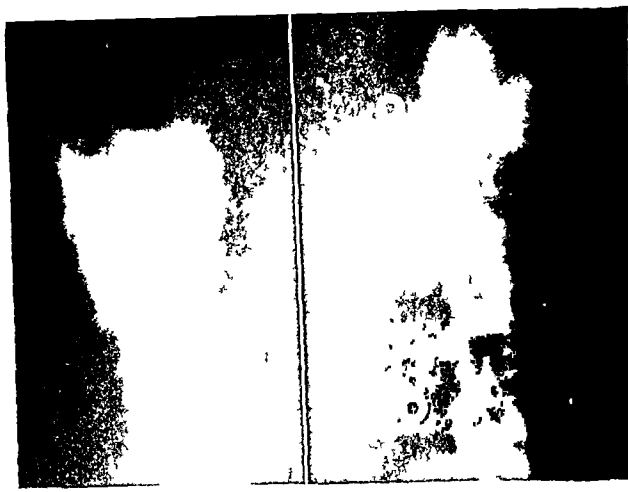


FIG. 5.

FIG. 6.

FIG 5. Case III. Fracture-dislocation of twelfth dorsal and first lumbar vertebrae. Anteroposterior view.
 FIG 6 Case III. Fracture-dislocation of twelfth dorsal and first lumbar vertebrae. Lateral view.



FIG. 7.

FIG 8.

FIG. 9.

FIG 7. Case IV. Lumbosacral strain. Straightened lumbar lordosis.

FIG. 8 Case IV. Lumbosacral strain

FIG 9 Case IV. Lumbosacral strain.



FIG 10 Case V. Sway back, increased lumbar lordosis



FIG. 11.

FIG. 12.

FIG. 11. Case v. Sway back, lumbosacral strain.

FIG. 12. Case vi. Sacralization of right fifth lumbar vertebra.



FIG. 13

FIG. 14.

FIG. 13. Case vii. Fracture of anterior lip of fifth lumbar vertebra and sacroiliac arthritis.

FIG. 14. Case vii. Sacroiliac arthritis.



FIG. 15. Case viii. Sacroiliac arthritis.



FIG. 16. Case ix. Fracture of pelvis and sacrum.

the diseased, injured, strained, or deformed area quiet.

The incision can be a single elliptical one from above the posterior superior spines, convexly downward over the sacrum or

(a) Fusion: Here Hibbs' operation of



FIG. 17.

FIG. 18.

FIG. 19.

FIG. 17. Case x. Osteoarthritis and tilting of last lumbar vertebra.

FIG. 18. Case xi. Lateral lumbar strain.

FIG. 19. Case xii. Narrowing anterior border of seventh dorsal vertebra; Kummel's disease.

spinal fusion, or some modification thereof, is satisfactory. If the pain is located in the

three incisions over the vertebral spines, and the two posterior iliac spines. A regular



FIG. 20. Case xii. Old fracture. Kummel's disease



FIG. 21. Case xiii. Pott's disease.

lumbosacral region, or sacroiliac joint, a "trisacral" fusion is best, in which not only the vertebrae, but also the sacroiliac joints are fixed. As this last operation was rather recently introduced, a short description may interest.

spinal fusion is then done of the last two or three lumbar vertebrae, with the upper two

sacral, and then the two posterior iliac crests are split with a broad flat chisel or bone saw. The inner layer of this bone is

- (6) Congenital conditions or deformities:
 (a) scoliosis, (b) absence of part of vertebra,
 (c) inequality of two sides of vertebra.

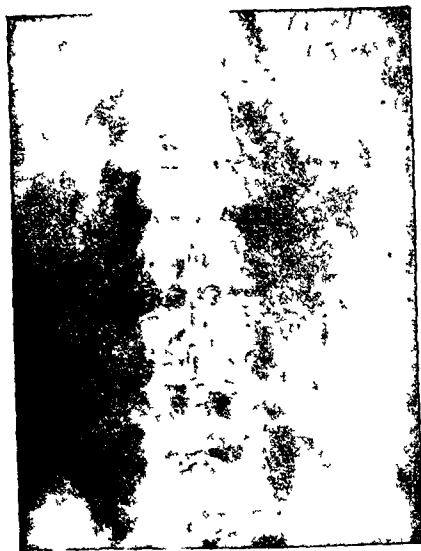


FIG. 22 Case XIII. Tuberculosis of first and second lumbar vertebrae

removed and placed over the lumbosacral joints to reinforce that fixation, and the outer layer is bent inward across the sacroiliac joints, after chips are first gouged out near or within the joint for fixation. The fascia and skin are then closed with interrupted sutures without drainage, or if much oozing occurs, silkworm gut drains may be passed through punctures away from the incision. We then place the patient on his abdomen, or back, on an air mattress for six weeks. This gives support without pressure. After this a plaster jacket may or may not be used as desired.

Indications: In general the indications for these operations are:

- (1) Tuberculosis of the spine (Pott's disease), especially in adults.
- (2) Fractures of the spine, dislocations or a combination including always spondylolisthesis.
- (3) Infantile paralysis with extreme weakness of the spine.
- (4) Arthritis, especially the chronic type, and if not generalized.
- (5) Sprains and strains, anatomical and mechanical variations, especially (a) lumbosacral; (b) sacroiliac.

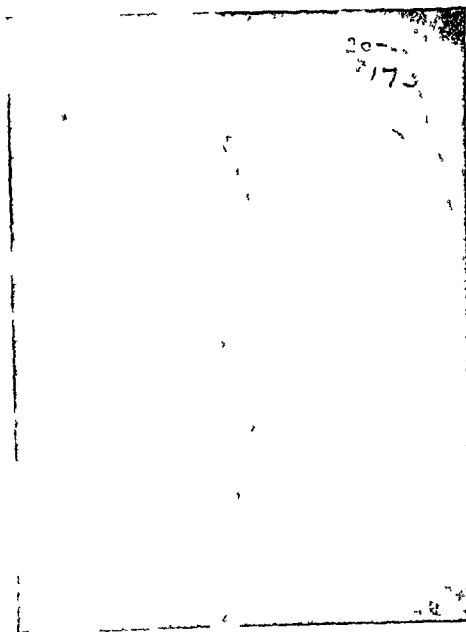


FIG. 23. Case XIV. Fracture of eighth, ninth, tenth dorsal vertebrae.

2. LAMINECTOMY: Another operation sometimes indicated is that of laminectomy. The chief indication for this operation is to relieve pressure upon the spinal cord, in cases of partial or complete paralysis. Here again we have the traumatic causes of fracture or dislocation of the spine. It is still a moot question as to whether these patients should be immediately subjected to operation, or not, but the consensus of opinion is that this operation should be done immediately upon such diagnosis. Occasionally there are cases of concussion or contusion of the cord, or of hemorrhage into the cord without fracture, or dislocation, which demand relief of pressure for paralysis, or prevention thereof. Then there are the inflammations again, as tuberculosis with paralysis. Lastly, tumors of the cord, membranes or vertebrae may require relief of pressure, and their removal.

CASE REPORTS

CASE I. L. W., female, aged forty-one, governess. (December 19, 1928.) Sprained

back in August, 1928 rescuing girl from drowning. Hurt ever since. Had treatment in Boston, wore leather jacket till October. Pain increasingly worse, then constant even in bed. Pain and tenderness located in lower lumbar spine. X-ray shows arthritis of lumbar spine.

January 28, 1929, Fusion done from second lumbar to second sacral vertebra, at Evanston Hospital.

Result: Pain in back entirely relieved from then on (Figs. 1 and 2).

CASE II. R. W., male, aged twenty-one, automobile mechanic. (December 11, 1929.) Two years ago had sudden occurrence of pain in lumbar back from lifting a heavy oil barrel. Pain worse at night and after work, and constant ever since. Located in deep, over lumbosacral joint.

X-ray: Spondylolisthesis of fifth lumbar on first sacral vertebra (Figs. 3 and 4).

January 6, 1930. Trisacral fusion at Evanston Hospital. Left hospital in six weeks.

July 21, 1930, last seen with no more back pain, returned to work, doing everything.

CASE III. K. T., female, aged thirty-two, housewife. (November 10, 1928.) Auto accident, open Packard car hit by another and turned over, with her doubled under it. Fracture dislocation of twelfth dorsal and first lumbar vertebrae (Figs. 5 and 6). Had also skull fracture, two broken ribs, fractured pelvis, and fractured left fibula.

In hospital on air mattress with traction until January 6, then went to New York City where she had spinal fusion done of four vertebrae in region of fracture dislocation.

Result: Now doing everything including riding horseback and jumping over hurdles.

CASE IV. E. M. male, aged thirty-eight. (May, 1930.) Hurt back in Army in 1918 in auto accident; gradually bothered him more and more until it hurt in lumbosacral and sacroiliac region every time he got up after sitting. Could not play golf or do anything much without pain. X-ray showed rather straightened lumbosacral angle (Figs. 7-9). Did not wish operation at this time.

March 1, 1931, with another surgeon; wore brace for six months from May, 1930; after three months has had no more pain. Does not try anything except ordinary routine. Does not even play golf. I would advise trisacral

fusion now, as here is a man thirty-eight years old incapacitated for any physical exertion either at work or recreation.

This is the type of back that gave 100 per cent cure with this operation in Dr. Hibbs' series of 147 cases of back strain.

CASE V. H. G., female, aged thirty-four, housewife. (May 16, 1930.) Bad place in back, always had a sway back, which is steadily getting worse. Very painful and tired in one spot on right side at times. When changing posture and when sitting it hurts worst; also hurts when tired and when lying flat, so draws up knees. Feels as if she must lean over to relieve it. Sway back. Increased lumbar lordosis present even when lying on back. Tender and painful over upper sacroiliac region.

X-ray: Sway back. Posterior angle of sacrolumbar spine decreased (Figs. 10 and 11).

Refused operation. Spinal belt or brace might relieve her.

CASE VI. L. W., male, aged eighteen, student. (June 2, 1930.) Hurt back on left side broad jumping one year ago; went to an osteopath and "had it jerked back into place." Recovered soon. Hurt again in basketball and then in baseball. Now hurts all the time. Worse when walks or gets up after sitting. Tender over left sacroiliac joint. All sciatic signs present.

X-ray: Left sacroiliac joint rough, and sacralization of right side of fifth lumbar vertebra, but not left, giving a congenitally potential weakness on left side (Fig. 12). Advised to stop strenuous athletics, wear sacroiliac belt, and have trisacral fusion done, if not well; or have operation and continue his athletics after six months. Chose the belt.

CASE VII. T. B., male, aged forty-three. (January 11, 1930.) Seventeen years ago lifted a Ford car over and hurt back immediately. Sore for three weeks. Leaned over to walk. No treatment. Twelve years later was reaching over to pick up handkerchief and coughed, pain recurred and lasted one week. Third time, four years ago carrying ashes up the cellar stairs lost his balance. Lay in bed and had chiropractor treatment which made it worse. Occasionally bothered ever since. Hurts in small of back, cannot bend. No pain when flat. Wears sacroiliac belt.

X-ray: Sacroiliac arthritis, small piece off of anterior part of body of fifth lumbar vertebra (Figs. 13 and 14).

Advised trisacral fusion if pain continues, or unrelieved by sacroiliac belt.

CASE VIII. R. R., female, aged fifty. (May 14, 1930.) Backache all her life. Ten years ago pain in back from leaning over to pick up a baby. Better for ten years but recurred last summer after golf lessons.

Examination: Pain and slight tenderness in sacroiliac joints. X-ray: Slight arthritis of sacroiliac joints (Fig. 15).

Treatment: Traction in bed, which relieved pain. Consider sacroiliac fusion if pain recurs and continues.

CASE IX. D. W., female, aged twenty, student. (July 7, 1929.) Auto accident. Fracture of pelvis and sacrum, with rupture of bladder.

Examination: Ecchymosis and tenderness anteriorly especially near symphysis pubis and posteriorly near sacroiliac region.

X-ray: Multiple pelvic fractures (Fig. 16).

Treatment: Bed on air mattress with traction to legs. Cured. If it had not relieved pain in back, should have sacroiliac fusion to immobilize these joints and prevent sheering upward of pelvis. Unnecessary here because made a complete recovery, and now does everything including tennis.

CASE X. A. N., male, aged forty-nine, laborer. (May 10, 1929.) Cook County Hospital Clinic because of pain in back.

X-ray: (15167E) "Osteoarthritis of lumbar spine and sacroiliac joints," also slight tilting of last lumbar spine causing a scoliosis (Fig. 17).

Treated by strapping spine and medication without relief, so entered hospital June 8, 1929, with history of pain in back, lumbosacral spine. This began fifteen or twenty years ago; when lifting a heavy load he felt a sudden strain in his back. Back had bothered him rather continuously since then. Has gone to several doctors, without help. Hurts particularly when he works, and more the last three or four years when pain has also run down into both legs.

Examination: Back, tenderness about fifth lumbar region, stiffness of lumbar spine, scoliosis to right in lumbar region.

June 10, 1929: Trisacral fusion, elliptical incision.

July 30, 1929: Left hospital walking without pain.

CASE XI. R. N., male, aged twenty-six, laborer. (Records and history incomplete.) Painful lumbosacral spine for some time (Fig. 18). Unable to work. May 17, 1927, entered Cook County Hospital for lumbosacral fusion. Left hospital six weeks after operation, without pain.

CASE XII. J. S., male, aged fifty, carpenter. (August 9, 1929.) First seen at Cook County Hospital. June 15, 1929, scaffold broke with patient, and he fell sixteen feet with scaffold on top of him. Hurt his back. Was told that x-ray at the time showed no fracture of the spine. Now has pain in region of seventh dorsal vertebra.

X-ray: Narrowing of anterior border of seventh dorsal vertebra. Kummel's disease (Figs. 19 and 20).

October 14, 1929: fusion of three vertebrae.

Result: Back much better, but is suing company, and still complains of his back.

CASE XIII. M. G., female, aged thirty-five, housewife. (November 10, 1930.) Pain in back three and a half years, since birth of her last child. In October, 1930 symptoms and x-ray made diagnosis of tuberculosis of first and second lumbar vertebrae (Figs. 21 and 22).

At Evanston Hospital November 24, 1930 fusion of eleventh and twelfth dorsal and first four lumbar vertebrae.

Result: January 15, 1931. Back pain has been relieved. Is now fever free for six weeks, and has gained weight. Now wearing Taylor brace.

CASE XIV. J. N., male, aged twenty-two (?), restaurant worker. (February 27, 1929.) Auto accident. Fractured right scapula and bodies of eighth, ninth and tenth dorsal vertebrae. Very little pain. (Fig. 23.)

Treatment: Air mattress with traction for six weeks, spinal braces for eight months. Operation indicated, but not advised because of mass of furunculosis and boils all over back.

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NEW INSTRUMENTS

A SEMI-FLEXIBLE BRACE

FOR THE SUPPORT OF THE LONGITUDINAL AND ANTERIOR ARCHES OF THE FOOT*

WALTER I. GALLAND, M.D.

NEW YORK CITY

THE difficulty in comfortably fitting with metallic braces the patient suffering from combined prolapse of the

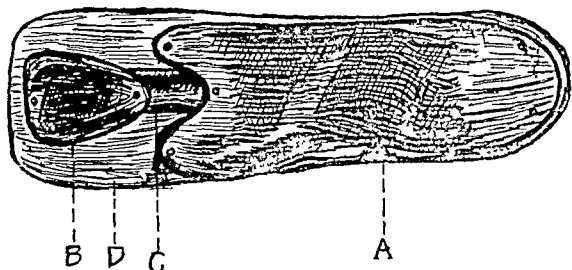


FIG. 1. View of semi-flexible brace from bottom, showing manner of insertion of metatarsal button. Distance between longitudinal and metatarsal elements of this brace will of course vary with individual foot. Various parts of brace are held together by rivets indicated in drawing. A, Longitudinal arch support. B, Anterior metatarsal button. C, Flexible metallic band. D, Leather covering.

anterior and longitudinal arches is frequently most baffling and at times well nigh impossible. The discomforts complained of by the patients are manifold. Usually on account of the inflexibility of the braces there is a tendency for the shoe to slip at the heel. This is caused by the fact that the brace fails to flex with the metatarsal-phalangeal articulations upon completion of the step and the rigid brace thus acts as a lever, forcing the back of the shoe away from the foot. It is obvious that the inflexible brace cannot furnish support to the constituent parts of the foot throughout its entire excursion in walking. Actually, the arches rest completely upon such an inflexible brace only when the foot is placed directly under the body axis as it is in standing. The rigid brace in walking is converted into an inclined plane at the

completion of each step, and either acts as a splint effectively preventing the normal flexibility of the foot or causes the foot to slide forward along its smooth rigid surface as it comes into equinus during the step. This unyielding unresilient support frequently causes extreme discomfort and even pain on account of the sliding of the foot and the changed position of the foot in relationship to the brace during the various phases of each step.

The brace herein described was designed to lessen some of the disadvantages of the rigid brace and to provide a more effective support to the anterior metatarsus, and to take care of the longitudinal arch without sacrificing the strength of the brace.

The modification which secures this desirable flexibility is applicable to most of the usual types of foot braces, including the Shaffer, the Whitman and the simple sole-plate braces. It consists in anchoring a metatarsal button preferably of triangular shape to the longitudinal section of the brace by means of a malleable metallic band. This button is placed with the base anteriorly under the metatarsal heads and the apex is riveted to the metal which links it to the longitudinal arch. The anterior edge of the plate for the longitudinal arch carries an indentation which permits the anterior button to be placed close to the longitudinal plate, if this is found necessary in adjusting the brace. The entire plate thus constituted is covered with thin sole-leather which should be moulded by the brace-maker over the plaster cast of the foot without wrinkling. This leather covering should extend anteriorly as far as the base

* From the Orthopedic Services of Dr. Charles H. Jaeger, Lenox Hill Hospital, and Dr. Harry Finkelstein, Hospital for Joint Diseases, N. Y. Submitted for publication November 9, 1931.

of the toes. It is fastened with copper rivets to the metallic sections of the brace. The flexible band which connects the anterior

malleable steel strip measuring $\frac{5}{8}$ by $\frac{1}{32}$ inch. This is cut to appropriate length and fastened with rivets which extend through

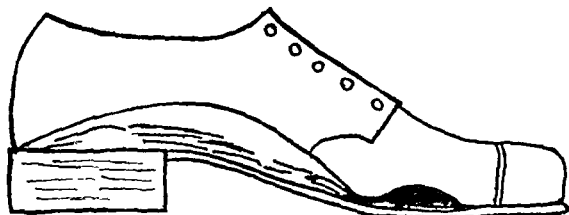


FIG. 2A.



FIG. 2B.

FIG. 2. A. Brace as it rests in a shoe. Angulation of anterior button in relation to longitudinal arch necessitated by heel of shoe is indicated. B. Position of brace at termination of step, illustrating flexion of brace at metatarsal longitudinal junction. It will be noted that anterior button remains in firm apposition with sole of shoe during entire step.

and posterior sections permits bending of the metatarsal upon the longitudinal segments of the brace. Thus provision is made for motion between the component portions of the apparatus. It will be seen that the metatarsal button will remain in contact with the metatarsus and be firmly planted with its base resting fully upon the sole of the shoe throughout the entire extent of the step, while at the same time the longitudinal brace by virtue of the flexible segment constantly follows and supports the longitudinal arch. The illustrations will perhaps clarify details of construction and the mechanics of this device.

In building the brace the greatest difficulty lay in securing a metallic band which would provide flexibility and at the same time would be durable and would not crack under the strain imposed upon it in walking. The first braces of this design which were constructed carried various types of springs to link the metatarsal button to the brace. It was soon apparent that no spring was able to stand the repeated bending around a very short arc, to which the connecting band must be constantly subjected. After many trials it was found that the most effective band and one which combined the utmost flexibility with the maximum durability was a

the leather covering to which the anterior edge of the metatarsal button is riveted.

The metal strip joining the two segments of the brace should be so bent as to compensate for the heel of the height commonly worn by the patient. This bending permits the proper inclination of the posterior section of the brace, while at the same time the anterior button rests parallel with the ground, and affords a firm support for the metatarsal arch in the accustomed posture of the foot as it rests in the shoe.

Although steel or any of the heavier alloys may be used in constructing the brace, I have found that aluminum or aluminum alloy is sufficiently strong for even the heavier patients. The rigid type of foot plate usually fractures at the junction of the anterior and middle thirds where the plate receives a shearing stress due to its inability to bend with the flexion of the forefoot. In the divided type of brace fracture is not likely to occur at this point, because it is here that the flexible element is inserted. We are thus able to use a lighter metal and not sacrifice the wearing qualities of the brace. The metatarsal button may be of metal or, in patients who exhibit extreme sensitivity of the anterior metatarsus, of sponge rubber. I have used this type of brace in approximately 100 cases.

THE LAVOIE SPLINT

IN FRACTURES OF THE HUMERUS*

G. S. FOSTER, M.D.

MANCHESTER, N. H.

MY colleague and friend, Dr. Z. A. Lavoie, has devised a very ingenious splint for use in fractures of each instance. In all fractures of the upper end of the humerus we consider it indispensable.

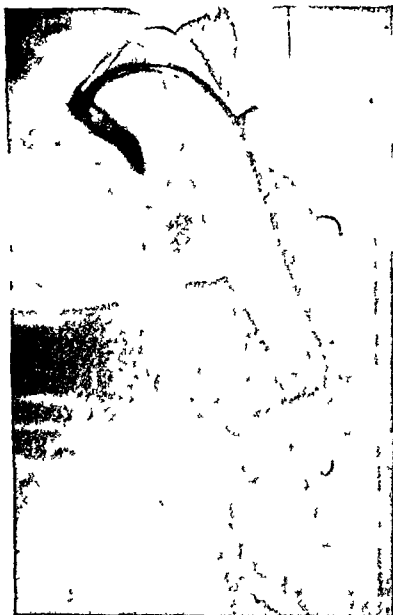


FIG. 1. Splint applied showing traction of the arm.

the humerus which seems to merit special attention. The mechanical knowledge always so ably shown by Dr. Lavoie has resulted in this special splint in an appliance which gives satisfactory results.

Fractures of the humerus, in any location, are always difficult injuries to deal with. Any form of apparatus which will render comfort to the patient and at the same time produce very satisfactory functional and appositional results, as well as excellent alignment, is, to say the least, a most welcome addition to the great number of fracture splints now on the market.

In our clinic we have used the Lavoie splint in several cases of fracture of the humerus with very satisfactory results in



FIG. 2. Splint applied, showing forearm resting in sling. (Notice extension straps.)

Its application can be made without the use of any anesthetic, thus relieving the patient of this extra strain and discomfort. Furthermore the proper use will give a very satisfactory apposition and alignment in almost every case.

Another very important point favoring the use of the Lavoie splint is that frequent readjustment without disturbing the tension power of the extension can be made. Constant extension or traction upon the lower fragment can be maintained and increased with no disturbance to the patient.

The satisfactory results obtained through the use of the Lavoie splint have prompted us to report it with the following description of the splint and the method of its application.

DESCRIPTION OF THE LAVOIE SPLINT

The splint is constructed of two parallel steel rods, A and B, placed approximately

* Submitted for publication November 4, 1931.

4 inches apart. A is the inner rod and B is the outer rod. The upper end of the outer of these two rods, namely rod B, is

and one below the plate. Thus the two perpendicular rods are held firmly fixed.

The upper of the two steel plates, namely



FIG. 3. Splint applied, showing ability of patient to use hand and forearm some while there is perfect extension on upper arm.

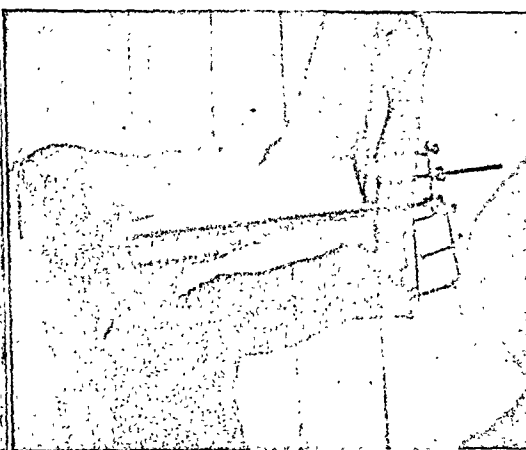


FIG. 4. Abduction of upper arm accomplished with relative ease. Splint applied and extension produced.

continued inward and upward forming two steel supporting braces D and C, which at a point opposite the upper end of the inner rod curve inward and downward so as to meet at the upper extremity, this latter curve forming support of this inner rod E. Thus it is seen that this outer rod, having an expansion D and C at the upper end, curves anteriorly and posteriorly, inward and upward, turning at the inner row to curve downward and inward, E. By this three-way curve, D, C and E, a heart-shaped rod brace results which firmly unites the upper ends of the two perpendicular parallel rods. The inner leg E of this heart-shaped triangle is well padded and covered with soft, smooth leather for protection to the axillary surface of the counter extension bearing force.

The lower ends of the two perpendicular parallel rods are threaded for a distance of 4 inches, K. Two steel plates, F and G, each 5 inches in length with a circular aperture at each end are then threaded onto the lower ends of these perpendicular rods.

The lower of these two horizontal plates, namely G, is held firmly in place at the lower ends of the perpendicular rods by two fixing nuts, L and M, one placed above

F, shades freely along the perpendicular rods over the threaded surface. At both extremities of this plate on the upper surface is attached a steel hook, H-H.

At the mid point on the under surface of this upper horizontal plate is attached a threaded rod, I, 5 inches in length. This threaded rod passes perpendicularly down through an opening in the center of the lower horizontal steel plate G, and an adjusting thumb nut, J, is then threaded onto this rod below the lower plate.

Two steel rolls, N-N, 3 inches in length, having a steel eye at the center are then hooked by these eyes on the hooks at the extremities of the upper steel plate F. These rolls N-N will thus be horizontal but perpendicular to the upper steel plate. Thus correctly assembled the splint is ready to apply.

From the description of this splint it is very obvious that the upper, horizontal steel plate can be moved upward or downward at will by merely turning the adjusting thumb nut to the right or left as desired.

APPLICATION OF LAVOIE SPLINT

To apply the Lavoie splint it is passed up over the upper extremity so that the padded brace, E-E, will fit snugly into

the axilla with braces *D* and *C* covering the deltoid muscle. Parallel, upright rods *A* and *B* thus run downward, the former along

H-H on the horizontal plate *F*. When thus attached the adhesive straps should be quite taut.



FIG. 5. Rear view of splint as it appears when traction is applied. (Note circular adhesive straps for retaining traction straps in position. Also indicated degree of traction of upper arm.)

the inner, lateral aspect of the upper arm and the latter along the outer lateral aspect of the upper arm. By this application of the splint the elbow will rest between the parallel, upright rods *A* and *B* at a point 4 to 6 inches above the steel rolls *N-N*.

Adhesive straps 3 inches wide are now applied to the inner and outer lateral surfaces of the upper arm, beginning at a point just below the site of fracture. These adhesive straps adhere to the skin for a distance of from 4 to 6 inches. These adhesive straps are reinforced by adhesive straps 3 inches wide circling the upper arm but not tightly enough to produce any constriction. Generally two of these circling adhesive straps are sufficient, placed about 2 inches apart.

The free lower extremities of the first adhesive straps are then split upward along the median line for a distance of 2 inches and then wound upon the steel rolls *N-N*. Several turns of these rolls are necessary to warrant holding. The steel rolls *N-N* are then attached to the hooks

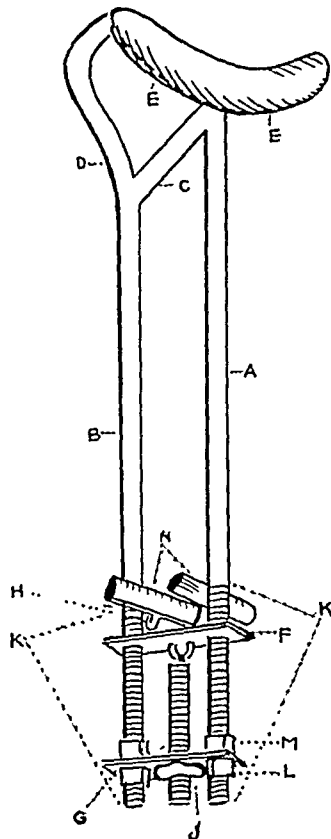


FIG. 6. *A* and *B*, Parallel steels, upright rods; *A*, inner, *B*, outer. *D* and *C*, Curved, supporting braces by expansion from upper end of upright rod *B*. *E*, Padded, supporting, curved brace uniting brace rods *D* and *C*, thus completing heart shaped upper extremity *D*, *C*, and *E*. *K-K*, Threaded section of parallel, upright rods. *F-G*, Horizontal steel plates threaded over parallel, upright rods. *F*, Movable on parallel, upright rods. *G*, Stationary as held by fixing nuts *L* and *M*. *H-H*, Steel hook attached to horizontal plate *F* at each extremity just inside parallel, upright rods *A* and *B*. *I*, Threaded rod attached to mid section of horizontal plate *G*. Screwed on over the lower end of this threaded rod is adjusting thumb nut *J*. This adjusting thumb nut *J* can be turned in either direction to release or extend as desired. *N-N*, Steel rolls with rings for attachment to horizontal plate *F* over hooks *H-H*. These rolls accept the extension, adhesive straps for proper extension and adjustment. The upper ends of the adhesive straps are attached to the upper arm below the site of fracture.

Thus applied the adjusting thumb nut, *J*, is turned to the right until proper traction is obtained as shown by the proper

apposition and alignment of the fractured ends above.

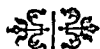
The forearm is then placed in a sling where it can comfortably rest in the position of flexion best tolerated by the patient. Thus the hand is left free for use in feeding or in accomplishing other functions. In fact the forearm can be flexed and extended at will and at certain intervals each day the sling can be removed so that such flexion and extension movements can be accomplished to keep the elbow free from any disability through loss of function.

From day to day the adjusting thumb screw J should be turned a little to maintain the proper amount of traction as

shown by the surface conformity over the site of fracture and by the roentgenograms.

The Lavoie splint is a simple piece of apparatus most ingenious in its construction, easily applied, comfortable for the patient and does not produce any bodily surface maltreatment. It permits the patient to be up and about and in no wise interferes with the use of the hand and forearm.

Above all its simplicity of construction, ease of application, comfort and freedom rendered the patient, coupled with the most excellent results obtained in fractures of the humerus, would certainly warrant its universal adoption in these cases.



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EDITORIALS

THE IMPORTANCE OF THE HUMAN ELEMENT IN MEDICINE*

As we gaze down the vista of medical history, we realize that it is a far cry from the beloved old doctor Milliken, in the O. Henry story, whose only equipment was "a can of calomel and a saw," to the skilled practitioner of today. This old doctor had the bedside manners of a Piute medicine man, and when he put his hand on a patient's head, they were said to feel like Captain John Smith just before Pocahontas went his bail. Yet, as my mind's eye travels down the Road to Yesterday, I see by the wayside many priceless assets which these old doctors

possessed, and which have been cast aside in favor of skill and cold science.

In spite of the vast strides that have been made in medicine and surgery, it seems to me that there is a gradually widening breach between physicians and their patients, which makes some of us yearn for the reciprocal feeling which existed in other days. When the general practitioner held sway, there was a feeling of perfect understanding between physician and patient. The physician was not only a healer of bodily ills, but was father confessor, advisor, a close friend and ally in times

* Address given by the retiring president of the Los Angeles Surgical Society, December 30, 1931.

of stress. Perhaps he did not have the technique that is possessed by the present-day specialist, but he did have a world of tenderness and understanding that healed broken spirits and brought new hope to discouraged hearts.

He was never in a hurry, and therefore he was able to probe down and find the cause which so often had resulted in various mental and nervous afflictions. He had never heard of psychoanalysis, but his sturdy courage and understanding uplifted the spirits of his patients and brought about a desire for health which reacted to effect a cure. He administered to the entire family. He was not above dosing the family watchdog or setting the leg of the prize bull calf. The result was, that he became the community oracle and was respected and trusted within a radius of many miles. When he decided that a leg must be amputated or an appendix removed, he first explained the necessity of such operations. The victims knew that he would do his best, and even though he inflicted upon them the most frightful agony, and they became permanently crippled or went down to death, the family still had implicit faith in his judgment and skill.

In this day, that complete confidence has been sorely shaken. It is stated openly by opponents of surgery that the doctors operate for a fee and not for the benefit of the patient. Stage comedians talk of an open season on adenoids, and of the good old days before there was a bounty on tonsils.

The medical and surgical profession today is a great battleground occupied by many opposing forces. Various schools of practice rush into the newspapers, making claims for miraculous cures and cure-alls. They tell their story over the radio, on the bill boards, by means of form letters, and with the hundred and one other devices that are barred by the ethics of our organization. Secure in the knowledge that we are following the higher standards which have come down to us through the ages, we make no reply to this barrage of

pseudo-medical shrapnel, but its effect upon the mind of the general public is far reaching and detrimental. It has tended to shake the faith of the afflicted of the civilized world in all branches of the medical profession.

The doctors created in the imaginations of fiction writers also have done much to undermine the confidence of the public. There have been a few physicians and surgeons drawn true to life, but the majority have been a caricature which derided the courage, courtesy, self sacrifice and kindness displayed by the medical profession in general. If they are not pictured as cynical, selfish, ignorant or generally impossible, they are made into paragons who never could exist in reality, and who undergo ordeals and survive circumstances that have no prototype in life.

Our aim as men and surgeons is to reflect a true picture of our profession and to bring about a better understanding with the public we serve. We should explain to them, in words that they can understand, the necessities which have brought about the era of the specialist, and before we shunt our patients through a long series of specialists, we should impress upon their understanding that each one is a master of his art, that he has devoted his entire life work to his particular branch of medicine or surgery, that no one physician or surgeon, though he lived to be as old as Methuselah, could possibly be expert in every branch of our profession, that when we refuse to make a complete diagnosis, we are working toward the end that our patient shall have every insurance against disease and death, and that only in this manner can a true picture be obtained when our patient is suffering from some obscure or baffling ailment. If we do not surround these explanations with a multitude of technical terms, we will build up that confidence in ourselves which is now so vitally lacking. We will resume the place held in the hearts of nearly everyone who formerly depended upon the old fashioned family physicians. We will cease to be

medical and surgical automatons and become, in the minds of our patients, human beings whose sole aim is to promote their health and happiness, men with an understanding of the trials and tribulations which continually afflict the world. We will still remain specialists, for only in this way can the best interests of humanity be served.

While it is necessary for the physician and surgeon today to exert himself for the best in science, it also is vital that he shall not lose the human touch which gave the old country doctor his priceless worth. We surgeons should not allow our patients to become merely cases. Ministering to the physical needs of humanity demands more than the wielding of the scalpel and the prescribing of drugs. There should be a bond between the physician and the sufferer that cannot be diagrammed. His heart must reach out with pity and understanding to the afflicted. Unless this is so, the faith, hope and trust which are necessary to the successful practice of medicine and surgery will be lacking.

Accurate diagnosis and scientific treatment are important, but the human element is equally essential. Neither can stand on its own feet unaided and be true to the standards set up by our profession. We, today, are threatened with becoming medical Robots, coldly scientific, highly skilled, but without hearts. I feel that each of us, when the time comes to face the surgeon's knife, wants more than just a skilled operator. We would like to feel that the man performing the operation cares a little bit about our personal wel-

fare. It is true that we cannot allow sympathy to impair technique or efficiency. We must not brood over failures, but must learn from them without losing courage.

A striking example of skill and human understanding was given by Sir William Osler. It is said that he always left behind him in the sickroom, hope and courage, which played a large part in his healing ability. It is this glorious combination of superlative skill and gentle tenderness which should be the aim of every surgeon. Flawless technique cannot take the place of sympathy.

If we build only on science and cold skill, we will erect a Frankenstein which will destroy us. There is no memory more beautiful than that of the old time country physician, who served his widely scattered flock twenty-four hours in the day. The mere knowledge that he was on the way to the sufferer brought a certain peace to the patient, and courage to the household. They knew he would give his best in their service. He bore their sorrows in his own heart; he brought their children into the world; he closed the eyes of the old folks in death and left a comforting word. He gathered more love than any other individual in the community. He had little time for scientific study, but men have won the Croix de Guerre for less distinguished service to their fellow man. We, today, should strive for the fundamental understanding which made these men great, and etched their history in the hearts of endless generations.

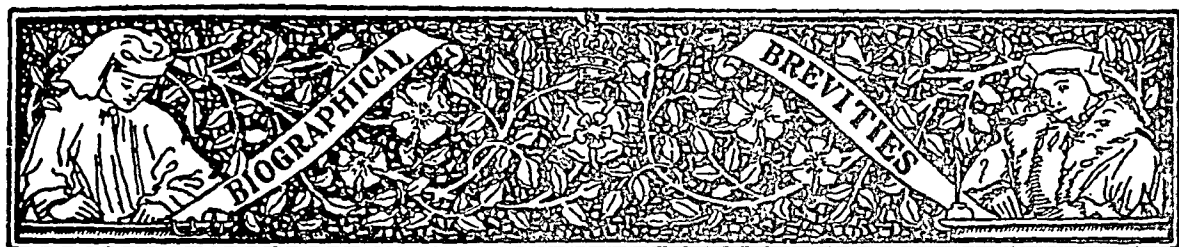
BURNS CHAFFEE

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WILLIAM PAUL CRILLON BARTON

[[1787?-1855]]



WILLIAM PAUL CRILLON BARTON

WILLIAM PAUL CRILLON BARTON was born in Philadelphia, November 17, 1786. His was an illustrious family. His father, William Barton, was a distinguished lawyer and designed the United States Seal. His brother, John Rhae Barton, was the originator of Barton's bandage, while an uncle was Benjamin Smith Barton, Professor of Botany in the University of Pennsylvania, and the successor to Benjamin Rush as Professor of Theory and Practice of Medicine in the University.

William graduated (A.B.) from the College of New Jersey (Princeton) in 1805 and received his M.D. at the University of Pennsylvania in 1808. He entered the navy as assistant surgeon the following year.

He was ordered to the United States in 1809 and found the lack of medical facilities and system deplorable. This led to his constant agitation for better supplies, a better system, and improved medical care of the ill, which agitation continued without abatement throughout his life.

He tired of sea duty after cruises on the *United States* and the *Essex* and requested and was granted duty in Philadelphia where he remained more or less until 1830. Among other accomplishments he abolished the nefarious custom of venereal fees in the American navy.

In 1814 he published, "Treatise Containing a Plan for the Internal Organization and Government of Marine Hospitals, and a Scheme for Systematizing the Medical Department of the Navy." Later he did a two volume work on "Medical Botany" and a "Compendium Florae Philadelphiae." In 1815 he was made Professor of Botany at the University of Pennsylvania.

Barton believed in higher standards of selecting recruits and felt much of the sick list was the result of accepting men physically below par.

In 1840 he made a West Indies cruise aboard the *Brandywine*. On the short trip 488 became ill, mostly with typhoid, scarlet fever, pneumonia and malaria. Barton wrote a work entitled, "Hints for Medical Officers Cruising in the West Indies."

In 1830 he was ordered to the Naval Hospital at Norfolk which had just been completed. The following year he returned to Philadelphia as senior member of the Naval Examining Board. In 1841 he advocated the keeping of a complete journal of all patients. The next year (1842) several new bureaus were formed and Barton was chosen the first Chief of the Bureau. Although the first Chief, Barton was not the first surgeon general of the Navy as the title was not created until 1869.

He had many staunch friends; also, many bitter enemies who resented his spirit of reform. His "liquor circular," limiting the use of medical liquor on ship-board, caused feeling to run high in the fleet.

In 1844 he resigned but while Chief, among many other things, he established a medical library for each naval medical unit. After resigning his office he served at the Pensacola Naval Hospital for about four years. He then became senior member of the Examining Board at Philadelphia. He remained in this position until his death, March 27, 1856.

In the Army Medical Museum at Washington there is a life-size bust of his likeness.

T. S. W.



[From Fernelius' *Universa Medicina*, Geneva, 1679.]

BOOKSHELF BROWSING

THE ROLE OF EXPERIMENTS ON ANIMALS IN THE TREATMENT OF DISEASE*

MODERN PHARMACOLOGY

ARTHUR D. HIRSCHFELDER, M.D.

MINNEAPOLIS, MINN.

IN order to understand what can be reasonably expected from the treatment of disease by "drugs," we find it helpful in the first place to think of the human body as a machine; and like other machines the parts of the living body wear out with age, its valves may leak, its engines may grow feeble. We may increase the efficiency of an automobile engine by "drugs." We may improve its "digestion" and its "breathing." We may treat its "anemia" by means of a better mixture of gas and air. We may strengthen and stimulate its "heart" to stronger contractions with "ethyl gas." We may guard it against "fever" in winter by keeping in the radiator the proper cooling mixture.

In addition to being a simple machine, however, the human body can repair its tissues and organs by healing, by growing removed parts anew, or by sealing wounds with scar tissue. The organs of the human body are often capable also of growing larger and so do the greater amount of work which a chronic disease may force upon them.

The human body may be invaded by microscopic organisms, bacteria and microscopic animals, which grow and penetrate into them just as one sees a fungus growth penetrate into a tree and destroy it. In addition, these bacteria produce poisonous substances (toxins) which are carried by the blood, and like other poisons, may injure the heart, the brain and other organs, and thus may finally cause death. These bacteria, if they are on the surface of the body, are easily killed by antiseptics; but if they have penetrated into the body and are covered over by living or injured tissues, the ordinary antiseptics cannot reach them; and only a few special drugs which circulate in the body can kill them without also injuring the heart, or other organs. Many disease conditions that occur late in life result not from the entrance of bacteria years before, nor from their immediate presence, but because the scars formed in the injuries due to the original infections shrink steadily year after year, even after the original infection has subsided. This closes up

*This is the fifth of a series of articles on the value of animal experimentation in medical progress. The next article will appear in an early issue.

tubes or openings that are necessary for the preservation of life and health.

From all this we can see that in order to cure a disease, relieve a symptom or allay pain, each "drug" must produce a definite kind of change in the workings of the body.

Historical Note. The oldest drugs in use have come down to us from prehistoric times, their usefulness having been found as matters of experience. The ancients knew the purgative value of the waters from mineral springs, and the shrines of Aesculapius, and other great Greek physicians, who mixed religion with their medicine, were located near mineral springs. The ancient inhabitants of India found out that the seeds of their opium poppy would produce sleep and soothe pain, and opium was carried to Egypt, Greece and China along all the routes of old world commerce. The Arabians knew that the balsams and aromatic herbs contained something that helped the healing of wounds, and brought these primitive antiseptics with them to Western Europe; though only in the fiction of Walter Scott were they potent enough to heal infected wounds as Rebecca cured the wounds of Ivanhoe.

The alchemists experimented with mercury in the hope of turning it into gold. By a fortunate trial they used it successfully in a salve to cure the venereal plague of syphilis, which, whether or not it was introduced into Europe by the sailors of Columbus, was first found to overrun Europe just after the discovery of America.

A great heart stimulant, digitalis, the active substance in the common foxglove, was discovered accidentally by an English physician, William Withering (1741-1799) about the time of the American Revolution. He found that an old woman in the country had cured several people of dropsy, upon whom physicians had failed, by means of a tea she had made of a mixture of several herbs, one of which was the foxglove. Withering thought that his

digitalis cured his patients of their dropsy by stimulating their kidneys. This we have since found to be incorrect. Almost a hundred years later the action of this drug on animals was studied by the English physician, Sir Lauder Brunton (1844-1916). He found that instead of stimulating the kidneys, it made the hearts of frogs and dogs beat slower and stronger, and therefore that it was a stimulant for the heart. In modern times it has been used as a heart stimulant and thousands of men and women live useful lives for ten and twenty years after they would have sunk into their graves but for Lauder Brunton's accurate experiments on dogs with the drug which Withering had given to the world, without knowing just how it acted.

Within the last twenty years this drug has been studied again from a different angle, and still greater benefits to humanity have resulted. A German physiologist, Theodor Wilhelm Engelmann (1843-1909), found that by touching the heart of a frog it beat again once, interrupting the regular rate of its contraction. He touched different parts of these frogs' hearts and made them contract irregularly in many different ways, and then showed that dogs' hearts responded in the same way as frogs' when they were touched in different parts. Ten years passed, and a country doctor, James MacKenzie, in a small town in England, puzzled by the irregular beats of his patients' hearts, began to study their pulses. He found that some pulses beat in two-step, some foxtrotted in four-step, some beat at a slow march of half-time, and some were out of step with every step and rhythm. He looked up Engelmann's studies on the hearts of frogs and found that the hearts of his patients acted just as those of Engelmann's animals had done. He reasoned that the disturbances in his patients must be quite like those that Engelmann had produced. This gave to physicians an entirely new understanding of hearts that beat irregularly. It was found that

some heart beats which had been previously thought to be signs of serious heart disease were merely normal heart beats or represented insignificant disturbances which needed no treatment whatever. This was especially true in many children, whose hearts are often a little irregular but who are otherwise perfectly normal, and do not need any treatment whatever, but can run play and fight like other children.

Others studied the exposed hearts of anesthetized dogs, and learned just what was wrong when the heart beats entirely out of step with any time or rhythm, the commonest and most dangerous ailment of all (auricular fibrillation). Then MacKenzie showed how this last disturbance could be controlled by digitalis, the heart made to beat slowly and strongly even though out of step. In 1916 Prof. Cary Eggleston (1884-) of New York together with Prof. Robert Anthony Hatcher (1868-) showed how doses of digitalis much larger than had ever been given before, doses which would make a doctor of the old days tremble with terror, were safe for animals and human beings. With these larger doses, patients panting for breath and swollen with dropsy on one day, were breathing quietly and free from dropsy and swelling on the next, with their pulse-beats large, strong and quiet though still irregular.

How a Drug Is Studied. Before we can use a "drug" safely and effectively, we must find out which, of all the substances that it contains, is the essential active factor. The first step is a chemical separation or manufacture. Then each substance must be tested out on animals. We must learn how it acts on each organ of the body in order that we may know in just what kind of condition it can be helpful. We must learn about how much of it will poison or kill an animal, to avoid such a dose when we give it to our patients. We must learn whether the dose that will produce the desired effect is too near to

the dose that would injure or kill the patient; for very many substances produce useful effects in the body but do so only when they are given in a dangerous amount.

The newest drugs are usually built up step by step in chemical laboratories, starting with some known substance which has, in general, the desired action, but when tested on animals, is found to be too poisonous for practical use. The chemists then make a whole series of new substances, each just a little different from the others. Since it is impossible to foretell which will act most strongly and have the least poisonous action, each of these substances must be tested out on animals. The best of them is then selected and becomes the new drug.

The great German pharmacologist, Paul Ehrlich (1854-1915), laid down the rule that in order for a drug to be safe for treating human beings, it must produce the desired effect in one-tenth of the amount that might be dangerous. This ratio, $\frac{\text{dose that kills}}{\text{dose that cures}}$, the so-called therapeutic ratio, must be greater than 10. This is the rule that, since the discoveries of Ehrlich, guides pharmacologists to make new drugs that are better and safer than those which we had before.

The Drugs That Produce Sleep. It is difficult to realize that before Oscar Liebreich's studies in 1869, if a patient needed a night's sleep, a doctor could administer only alcohol or opium, and that thousands of persons innocently became the slaves of opium on this account. Oscar Liebreich showed by experiments on animals that sleep could be produced by chloral hydrate, a drug which was much less likely to form a habit in patients than opium, and yet would bring placid sleep to tired eyes. Experiments on animals showed that chloral is harmful to the heart and gave us the doses that can still be used with

safety, but not for persons whose hearts are weak. Later investigations by Eugen Baumann and Alfred Kast in 1888, gave us sulphonal and trional, less poisonous to the heart but slower in their action. Then the great Berlin chemist, Emil Fischer (1852-1919), who was trying to make artificial caffeine in the laboratory, in 1903 gave one of his new substances to a physician, Joseph von Mering (1849-). Von Mering tried it out on many rabbits and dogs and found quite unexpectedly that it produced sleep in doses that were much smaller and safer than any of the drugs used previously. Thus it became known that these drugs, now called barbital (veronal) and phenobarbital (luminal) and a host of other very similar drugs (amytal, dial, etc.) are the best and safest sleep-producing drugs in use today; and many a person who needs rest during an illness is saved from becoming an opium addict by these researches of Emil Fischer and the dogs of von Mering.

From the studies of Fischer and von Mering came a still further unexpected result. It was found that small doses of phenobarbital were far better than bromide of potassium for preventing attacks of that terrible disease, epilepsy, and that this result could be gotten without dulling the intellect of these unfortunates as bromides had done. Thus an additional boon was conferred upon mankind.

Later studies in this disease included the experimental treatment of the blood of dogs with simple acids and cooking soda (bicarbonate of soda) and the subjection of others to starvation followed by diets rich in fat but poor in starches which led to an understanding of the effects produced by slight changes in the alkalinity of the blood. These studies led Peterman and Harry Frederic Helmholtz at Rochester, Minnesota, to the demonstration that many children could be further saved from epileptic attacks, or the attacks made much rarer,

by simply placing them on a diet rich in fats but poor in sugars and starches. As the outcome of experiments on animals, another awful disease had been mollified, and though not completely conquered, there are indications that it may be completely conquered in the not too distant future.

The Conquest of the Hookworm. The poverty and laziness of the "poor white trash," who made up such a large part of the population of the southern States at the beginning of the present century, was found to be due chiefly to the fact that most of them had parasitic worms (hookworms) in their intestines which sucked the blood through the bowel walls, and so rendered them anemic, listless and weak. Many drugs were studied in animals; and at last three drugs, thymol, oil of wormseed (chenopodium) and carbon tetrachloride (the ordinary non-inflammable cleaning fluid), were found which were safe to use in human beings and which would rid the sufferers of their hookworms without injuring the patient. By the cooperation of the Rockefeller Foundation and the Health Boards of the southern states, these drugs have been given to millions of men, women and children, who have become rid of their parasites and have become strong and well again. Indeed it is to the use of these drugs, and the vigor which they have brought to the native population, that one can ascribe in large part the prosperity which has come to the southern States in the last few years.

Amebic Dysentery. One of the most serious and stubborn diseases, which occurs widely in the tropics and very frequently also in all parts of the United States, is a certain form of dysentery, sometimes accompanied by abscesses of the liver. This disease is due to a microscopic one-celled animal about the size of the point of a pin, called the ameba, or more accurately, the *Entamoeba histolytica*. The amebae multiply and burrow

into the wall of the large intestine and in between its layers. There they remain hidden away, doing damage for years; and then they may even travel up to the liver and form big sacs or abscesses there. Many people die of this form of dysentery, and until a few years ago it was very resistant to all forms of treatment. But in 1912, Prof. Leonard Rogers in India and Col. Edward B. Vedder of the U. S. Army Medical Service began to treat this disease by injecting a drug called emetine under the skin. They had proved that this drug would circulate through the body and poison the amebae wherever they were found, both in the walls of the intestine and in the abscesses of the liver. It was the first time that this disease could be cured in any considerable number of cases, and this drug is still used for this purpose. However, as so frequently happens, the drug is quite poisonous to the patient; the dose necessary to cure is very near the dose that may cause unpleasant symptoms. It has therefore been necessary to get other drugs which would help out the action of emetine and which could be used with less discomfort. It was soon found the neoarsphenamine (neosalvarsan) would accomplish this purpose; and since 1923 another of the arsenic group of drugs (stovarsol), made by Prof. Fournieu of the Pasteur Institute in Paris, has been used with great success. One of the advantages of stovarsol is that it can be given by mouth instead of being injected into the veins; and except for occasionally causing diarrhea, it is very satisfactory. Still another drug has been used for this purpose, a preparation known as anayodin (yatrion), which is a quite simple and harmless compound that has been made and introduced in Germany. This drug may be given by mouth or used as an enema, introduced directly into the rectum so that it comes in close contact with the amebae. The action of anayodin and stovarsol, like other drugs, was not suspected until they had been tried out on

animals, but now physicians have at their disposal three drugs which they may use, one after another, to bring about the cure of a disease which twenty years ago baffled every method of treatment and caused the death of many persons.

Leprosy. The most horrible and loathsome of all diseases known to man is leprosy, which disfigures the face, causes fingers, toes and noses of patients to shrivel and shrink, and kills thousands of people in the most awful manner. Throughout the centuries this disease has incited horror, and lepers have been banished to leper colonies on deserted islands and have been left there to die, accompanied only by a few faithful martyrs of physicians and attendants who often have themselves contracted the disease from the patients. No remedy was known until 1915, though there had been a belief among the inhabitants of India that an oil (chaulmoogra oil) from a certain Indian tree, gave some benefit when it was taken by mouth. In 1915, Prof. Leonard Rogers of India and Prof. Victor G. Heiser of the U. S. Public Health Service in Hawaii, with the collaboration of a staff of chemists, made several new chemical compounds from chaulmoogra oil. They tested these out on animals and found that they were not harmful, and from these experiments learned the dose that would be safe to give to human beings. These medicines for the first time in history really cured patients who had leprosy. The cure is slow, requiring at least ten months; and severe cases cannot be completely cured. But in thousands of cases the dread disease has been blotted out and the unfortunates have been able to return to their homes free from any contagion or blemish.

In the last three years, Professor Roger Adams of the University of Illinois, by a series of wonderfully skillful chemical syntheses, has prepared a number of new substances which are very similar to the chaulmoogra compounds in chemical

composition, but which, in the test-tube, are several times more active in their attack on the bacillus of leprosy, though when injected into animals they are no more poisonous. These are at present being tested out on patients with leprosy, and give new hope that soon this disease may be cured with greater certainty and greater speed than is at present possible with the derivatives made directly from chaulmoogra oil.

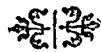
CONCLUSION

The foregoing represent a few of the controls over diseases that have been made possible only through experiments upon animals. In every field of disease, new experiments are in progress, new light is being thrown upon the cures yet to come, of diseases which are not yet conquered. For many of the commonest and most dreaded infections we still have no satisfactory drugs; but these can come only by continued study along the same lines as have brought success in the past.

GOVERNMENT REGULATIONS REQUIRING THE TESTING OF DRUGS UPON ANIMALS

Not only is experimentation upon animals necessary for the discovery of new drugs, but the laws of the United States require that every sample of certain important well-known drugs must be tested out on animals in order to determine that it is strong enough to accomplish what is expected of it and safe enough to be used upon human beings. Thus the law requires that every batch of serum against diphtheria or lockjaw, every vaccine, every sample of insulin for diabetes, every sample of digitalis or aconite for heart disease, must be tested out upon animals in the laboratory before it is declared safe for use on patients.

Experiments upon animals have taught us the exact causes of many of the diseases that affect our health. It is by experiments upon animals that the remedies for these diseases have been found and made safe and effective; and it is only by experiments upon animals that the diseases, for which no specific remedies have yet been found, will probably be conquered in the future.



BOOK REVIEWS

THE MEDICAL ANNUAL, A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX, 1932. Bristol, John Wright & Sons Ltd., Fiftieth Year, Jubilee Volume.

The fiftieth volume of this famous publication comes to us labeled "Jubilee Volume" and, has, as a special feature, 204 portraits of previous contributors. The volume is sent direct from England with no American agent mentioned. This probably accounts for the inclusion of 150 pages of advertisements which seems to be an English custom. These were formerly eliminated from the American edition. There is also included a list of books and journals which is preponderantly English. The volume is larger than any we have yet seen, and, as usual, quite up-to-date. Each subject is covered by an outstanding authority and a rapid résumé is given of the advances during the year. We have always found this annual a handy reference book for rapid orientation in the more recent advances in medicine. This Jubilee Volume lives up to the reputation of its predecessors; it is well printed, and beautifully illustrated.

YELLOW FEVER, An Epidemiological and Historical Study of Its Place of Origin. By Henry Rose Carter, Late Asst. Surg.-Gen., U. S. P. H. S., Edited by Laura Armistead Carter and Wade Hampton Frost. Balt., Williams & Wilkins Co., 1931.

The book here presented, as planned by Dr. Carter, was to have been a history of yellow fever to the present time but was undertaken when the author was ill. As stated by the editors, "Even this was completed only by working throughout an illness severe enough to confine him to bed for long intervals, and, during his last year, continuously." The editors have done splendidly in taking the author's notes and completing the work approximately as far as he went. Much has been written of the American work on Yellow Fever, particularly the work done by those heroes of science—Reed, Carroll, and H. R. Carter who in 1898 qualified

the extrinsic and intrinsic parts of incubation, one of the distinctive advances in the subject to which the last named devoted his life.

This volume is a distinct credit to American medical literature and the editors are to be congratulated upon making the ms available for publication. No student of the history of medicine or of tropical medicine should fail to read and possess this volume.

MEDICINE IN VIRGINIA IN THE EIGHTEENTH CENTURY. By Wyndham B. Blanton, M.D. Richmond, Garrett & Massie, Inc., 1931.

This book is a delightful presentation of source material for the history of medicine in this country. It is bound in a canvas cover decorated with an Indian motif quite in keeping with the contents.

The story of "Medicine in Virginia in the Eighteenth Century" is told in an interesting narrative style. It is interspersed with reproductions of original documents, the title pages of important publications of the time and with portraits of the important medical men of the day. The publication is a typical example of what may be done in the interest of history of medicine if only enough enthusiasm and ability are put into the work. When volumes like this appear about each state in the union, we will have much medical historical Americana to be proud of. Dr. Blanton is to be congratulated upon producing an outstanding book of this kind.

A DESCRIPTION OF THE PLANES OF FASCIA OF THE HUMAN BODY, With Special Reference to The Fascia of the Abdomen, Pelvis and Perineum. By B. B. Gallaudet, M.D., Dept. Anat. College of Physicians and Surgeons, Columbia Univ. N. Y., Columbia Univ. Press, 1931.

This monograph is based on the dissection by the author of thirty-four adult human bodies. In the opinion of the author, the fascial planes are inadequately described in the standard American and English textbooks, and he feels that he has corrected several

anatomical errors which have become imbedded in tradition.

HEALTH FOR TRAVELERS, Hygiene and Health Preservation in the Tropics, Orient, and Abroad. By the Staff of the Pacific Institute of Tropical Medicine, within the George Williams Hooper Foundation for Medical Research, Univ. of California. Edited by Alfred C. Reed, M.D. San Francisco, J. W. Stacey, Inc., 1931.

This book, published under the auspices of the Pacific Institute of Tropical Medicine, is a splendid handbook to take along on a trip through the Tropics. Health rules are laid down and if the traveler reads this book and follows the rules, it should add to the pleasure and comfort of the trip.

FRANZ V. HOFMEISTER'S VERBANDTECHNIK. Neu Bearbeitet und Herausgegeben von Dr. Otto Jungling. Ed. 4, Berlin, Urban & Schwarzenberg, 1932.

Hofmeister's work revised by Dr. Otto Jungling is a splendid elementary presentation of the art of bandaging. It is thoroughly complete and up-to-date and of great value to young physicians and surgeons. This work should be translated into English.

THE SIGN OF BABINSKI, A STUDY OF THE EVOLUTION OF CORTICAL DOMINANCE IN PRIMATES. By John F. Fulton, M.D., Sterling Prof. of Physiology, Yale Univ. School of Medicine, and Allen D. Keller, M.D., Prof. of Physiology and Pharmacology, School of Medicine, Univ. of Alabama. Springfield, Ill., Charles C. Thomas, 1932.

This book is representative of the highest form of scientific research. It starts off with the first and second pages of Babinski's original paper describing the phenomenon of the toes. For the scientific research worker, it will be found indispensable. The extensive work of Dr. Frederick Tilney on "The Brain from Ape to Man" is well supplemented by Dr. Fulton's monograph and it is to be hoped that many others will follow.

A TEXT-BOOK OF NEURO-ANATOMY. By Albert Kuntz, PH.D., M.D. Phila., Lea & Febiger, 1931.

In 350 pages, the author has succeeded in giving the essentials of neuroanatomy. Naturally, this book is not to be compared to the larger works on this subject but it has its definite place as an introduction to the larger and more complete volumes. Many may contend that a little knowledge is a dangerous thing and that the student should either study the entire subject completely or else leave it alone. However if the student is interested, he may want to go further into the subject. With these limitations, therefore, this book has a very definite place and may be recommended.

DER HEUTIGE STAND DER KNOCHENBRUCHBEHANDLUNG. Hefte zur Unfallheilkunde. Vol. 2. By Prof. Dr. M. Borchardt. Berlin, F. C. W. Vogel, 1932.

This reprint from the *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, is a 72 page article detailing the treatment of the more common fractures as it is practiced in Borchardt's clinic. The methods of treatment here detailed are on the whole what might be called conservative measures. The article is well illustrated and will be read with interest by all surgeons interested in the treatment of fractures.

THE INTERVERTEBRAL DISCS. By Ormond A. Beadle, M.D. London, H. M. Stationary Office, 1931.

This small monograph is a discussion of the great work of Schmorl, on the pathology of the discs. The author has had an opportunity to study Schmorl's specimens and data in a very thorough manner. The material presented in the monograph represents the results of those observations and constitutes the first extensive account of this work in the English language. The monograph is beautifully illustrated by photographs and photomicrographs.

No one who is interested in manifestations of pathology in the spine should fail to read this exceedingly valuable contribution.

KONSTITUTION UND VERERBUNG IN DER ORTHOPÄDIE. By Prof. Dr. B. Valentin. Stuttgart, Ferdinand Enke, 1932.

This is a short article of 30 pages which discusses the constitutional and hereditary

aspects of certain disorders of bones and joints. The paper has nothing particularly new to offer in this way, the subject having been covered more extensively in other monographs in the past.

DIE GESUNDE UND KRANKE WIRBELSÄULE IM RÖNTGENBILD. Pathological-anatomical investigations by Geh. Med.-Rat Prof. Dr. Georg Schmorl. With the roentgenological cooperation of Dr. Med. Herbert Junghanns. Vol. 23, Supplements to the *Fortschritte auf dem Gebiete der Röntgenstrahlen*. Ed. by Prof. Dr. Grashey, Köln. Leipzig, Georg Thieme, 1932.

For a number of years important anatomical researches on the spine have been in progress in the pathological department of the Friedrichstaedter Krankenhaus at Dresden. In 1925 Schmorl began to remove every spine for examination as a post-mortem routine, and during the succeeding five years about 7000 spines have thus been examined by him. Many of them are preserved in the museum. It is stated that the museum contains about 600 complete spines on its shelves; a similar number awaits the time when there will be more room. There is a great wealth of material in small preparations of parts of spines set up by a very durable technique. During these investigations Schmorl has paid attention to many problems of the anatomy and pathology of the spine. New light has been thrown on some questions hitherto unsettled, and particular attention has been given to the intervertebral discs and the articulations of the vertebral bodies. An attempt has been made to connect these changes with important deformities of the spine as a whole, and in particular kyphosis.

The illustrations are numerous and beautifully reproduced. The roentgenographic technique is superlative, but this is explained by

the fact that most of the x-ray illustrations are of specimens, not of the spine *in vivo*. The teaching value of the work is great. It should be in the hands of every roentgenologist and orthopedist.

DIE DICKDARMSCHLEIMHAUT, IHRE NORMALE UND PATHOLOGISCHE FUNKTION IM RÖNTGENBILDE. (The Mucous Membrane of the Colon; Its Normal and Pathological Function, as Seen Roentgenographically.) By Priv. Doz. Dr. Werner Knothe. Director, Roentgen Dept., Second Medical Univ. Clinic at the Charité, Berlin (Director: Prof. G. v. Bergmann). Leipzig, Georg Thieme, 1932.

The direct anatomical roentgen diagnostic method, by visualization of the mucosa of the alimentary tract, the so-called "relief method," has been applied to all segments of the digestive tube. In this valuable little work the author has sought to study particularly the normal and pathological functions of the colon through alterations in the appearance of the colonic mucosa through this "relief method." The pioneer work of Forssell is taken as the starting point, and from this the author has investigated and correlated the appearances of the colonic mucosa in the normal as well as in the functional and organic diseases of this organ, including neoplasm, non-specific inflammations, tuberculosis, inflammatory changes in the appendix with secondary manifestations in the colon, and the role of the structure of the mucosa in diverticulitis of the large bowel.

To physicians not familiar with this modern trend in roentgen study of the alimentary tube, the illustrations of the normal and pathological mucosal reliefs will be somewhat startling, but the method represents a definite forward step and one which must be adopted into our daily roentgenological practice.



PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D., AND LOYAL DAVIS, M.D.

NINTH INSTALLMENT

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CHAPTER XXVI
THE AXILLARY NERVE
MOTOR SYMPTOMS

The muscles supplied by the axillary nerve are the teres minor and the deltoid. When they are paralyzed abduction of the hanging arm is impossible. Isolated paralysis of the axillary nerve is rare, but it is commonly observed in brachial plexus lesions. It may result from fracture of the head of the humerus and subglenoid dislocations. It has been observed following prolonged stretching in sleep and anesthesia. A mononeuritis affecting this nerve and tumors are encountered rarely. It was rarely injured alone as the result of war injuries. Purves-Stewart and Bénisty did not observe a single instance. (Figs. 214, 215.)

SUPPLEMENTARY MOVEMENTS: Satisfactory abduction of the arm when the axillary nerve is completely paralyzed occurs very frequently. The frequency may be seen from the report of Bunts who, in 1903, found that in 19 cases of axillary nerve paralysis 7 patients recovered function. Of the 7, 4 recovered function in the absence of function of the deltoid muscle.

The physiology of the movements of muscles about the shoulder is somewhat complex and current conceptions are obscure in some particulars and controversial in others. Until recently it was the accepted view that in raising the humerus to a straight angle, the deltoid elevates the arm approximately to a right angle, after which elevation is completed by scapular rotation. This view will probably be modified as the result of the investigation of Stookey, who showed that the first cycle of elevation is accomplished by the action of the deltoid and supraspinatus, which raise the humerus to an angle of about 60 degrees. This is accomplished by slight rotation of the scapula. The second cycle is accomplished principally by



FIG. 214. Attempts to abduct arm in paralysis of axillary nerve.

[463]

rotation of the scapula due to the action of the serratus magnus, trapezius, rhomboidei and levator anguli scapulae muscles which raise the arm to an angle of approximately 115 degrees



FIG. 215. Atrophy of deltoid muscle in axillary nerve paralysis.

to a straight angle due to the action of the supraspinatus and deltoid muscles. During this movement there is only slight rotation of the scapula. Stookey pointed out that the coracobrachialis and the clavicular head of the pectoralis major were associated with the deltoid in the final stage of elevation.

The importance of the supraspinatus muscle was emphasized by Codman who believed that the deltoid could not act as an abductor of the arm unless accompanied in its action by the supraspinatus whose power furnishes a fulcrum for the action of the deltoid. This view was expressed in part by Winslow, in 1749. As pointed out by Stevens, the subscapularis,

the infraspinatus and the teres minor act as tractors to pull the head of the humerus into the glenoid cavity and fix it firmly. Beyond a certain point, the infraspinatus and teres minor behind and the subscapularis in front may possibly take on an added though limited function; namely, that of abductors as aids of the deltoid.

Duchenne showed in his case of supplementary movements in a deltoid paralysis that it was the supraspinatus, the serratus and the trapezius which supplied the power. Kennedy pointed out in addition the influence of torsion of the vertebral column. Hoffman considered the pectoralis major of prime importance. It is the opinion of Kron that the pectoralis should, with the supraspinatus, pull the head of the humerus into the glenoid cavity while the serratus by rotating the scapula elevates the arm. Loewe attributed the action to the supraspinatus and trapezius.

From studies of clinical cases and preparations of anatomic models, it appears that there are two distinct types of supplementary motility which permit abduction of the humerus in complete paralysis of the deltoid muscle. Of course, the movement of torsion or bending of the spine need not be included since it only increases the distance between the extended hand and the ground and in no way abducts the humerus.

The movement of abduction backward seems never to be supplemented so that such a movement as is necessary to put one's hand in the hip pocket is impossible.

The first type of supplementary movement is that in which the head of the humerus is firmly fixed in the glenoid cavity, probably by the subscapularis, the infraspinatus, the pectoralis major and the supraspinatus muscles. During this period, external rotation of the humerus occurs. The serratus magnus and trapezius, with the rhomboidei and the levator anguli scapulae then produce rotation of the scapula and elevation of the humerus. Some actual abduction may likewise occur. Thus the first and second phases of abduction are combined but the second phase overshadows the first. The third phase may be

concluded by the supraspinatus, the clavicular head of the pectoralis major and the coracobrachialis.

The second type is that in which the first phase of abduc-

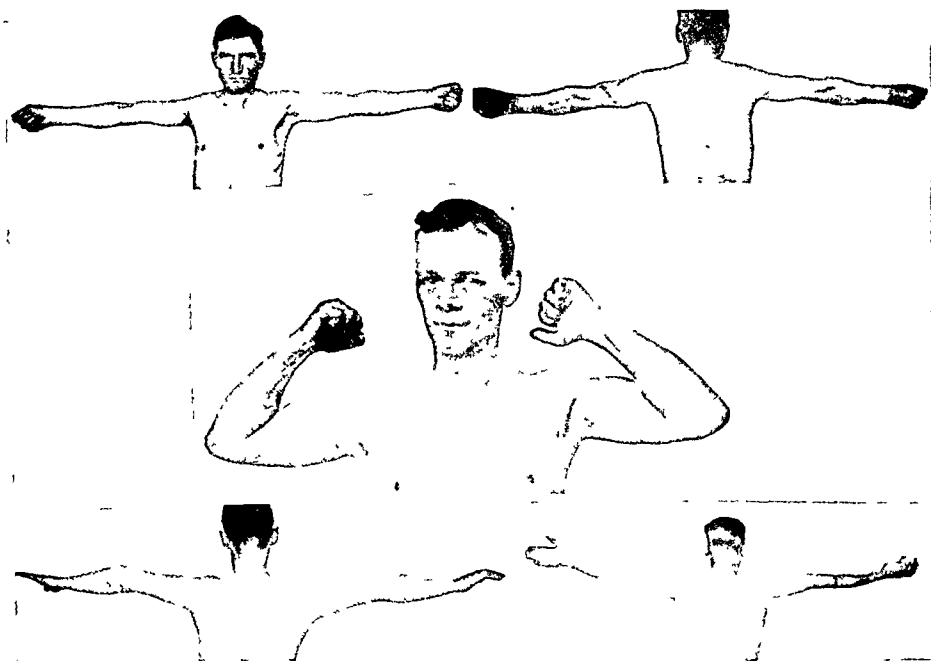


FIG. 216. Supplementary muscle movements in axillary nerve paralysis.

tion of the humerus may occur as the result of combined action of the supraspinatus, the infraspinatus acting simultaneously with the coracobrachialis and possibly the long head of the biceps. The second phase of abduction occurs as in the normal individual, by the action of the serratus magnus, the trapezius, the rhomboidei and the levator anguli scapulae. The third phase is completed by the coracobrachialis, the clavicular head of the pectoralis major and the supraspinatus. (Fig. 216.)

SENSORY SYMPTOMS

The sensory loss occupies an area on the outer side of the arm and shoulder cap corresponding closely to the distribution of the fifth cervical root. Frequently but little loss of pain

sense is found in this area. When injured with the musculocutaneous nerve, recovery commonly occurs first in the axillary nerve. (Fig. 217.)

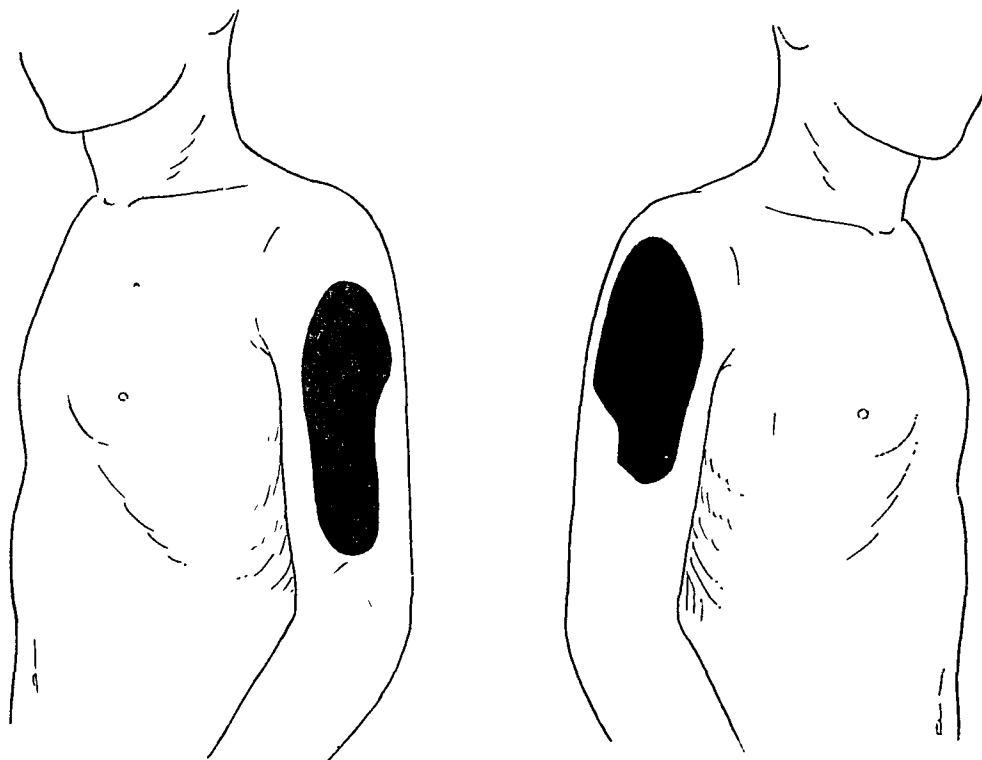


FIG. 217. Sensory loss in axillary nerve paralysis.

ANATOMY

The axillary nerve arises from the posterior cord of the brachial plexus. The posterior divisions of the fifth and sixth cervical spinal nerves supply fibers to make up its trunk. Its origin is occasionally behind the pectoralis minor, rarely below the inferior border of this muscle and always posterior to the axillary artery. The nerve may leave the posterior cord of the plexus anterior, external or internal to the radial so that there may be very many variations in its mode of origin. The nerve descends upon the subscapular muscle to enter the

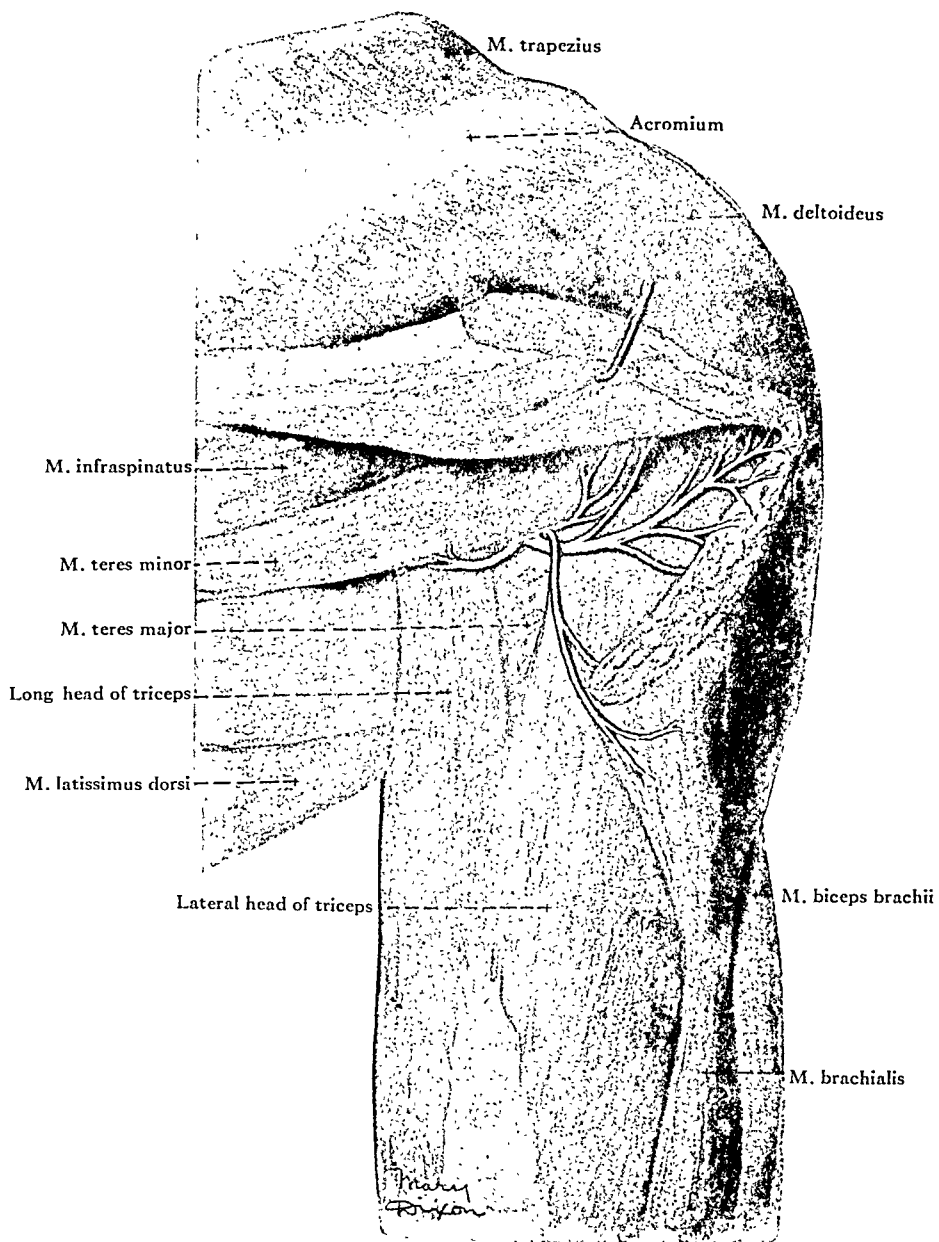


FIG. 218. Anatomical course of axillary nerve.

quadrilateral space. It then turns about the posterior and external surface of the surgical neck of the humerus to end within the deltoid muscle. (Fig. 218.)

In the axilla as it lies upon the subscapular muscle it is hidden behind the axillary artery. The posterior circumflex artery and vein, which lie above the nerve, accompany it to enter the quadrilateral space which is formed by the teres minor and subscapularis muscles above, the latissimus dorsi below, the long head of the biceps laterally and the humerus medially. Of all the branches of the brachial plexus in the axilla, the radial is the only nerve in close relation to the axillary. The other nerves lie on a more anterior plane.

As the nerve passes obliquely and externally through the quadrilateral space it lies close to the inferior part of the capsule of the shoulder joint. Leaving this space the nerve, still accompanied by the posterior circumflex artery, wraps itself from behind forward about the surgical neck of the humerus. It is separated from the bone by a strong aponeurosis of the deltoid muscle.

A small ramus from the axillary nerve is distributed to the marginal portion of the subscapularis muscle. According to Rudinger two branches supply the shoulder joint. The superior ramus arises within the axilla and supplies the anterior part of the joint capsule while the inferior twig which arises within the quadrilateral space is distributed to the inferior part of the capsule.

The *branch to the teres minor muscle* is of considerable size and arises as the axillary leaves the quadrilateral space. It then has a recurrent course upward and anteriorly to reach the muscle into which it disappears by numerous filaments.

The *cutaneous branch* of the axillary arises from the branch to the teres minor and occasionally forms a common trunk with it. The nerve perforates the superficial aponeurosis at the posterior edge of the deltoid muscle. As it becomes superficial it divides into innumerable terminations, which ramify within the skin. Some of these twigs anastomose with branches of the

internal cutaneous nerve of the arm to supply the skin over the deltoid area.

The *terminal* branches, two in number, end within the deltoid muscle. The posterior terminal is shorter and may arise from the branch to the *teres minor*. It is distributed to the spinal portion of the deltoid. The anterior branch is longer and supplies the anterior fibers as well as the acromial and clavicular fibers of the deltoid. Some of the twigs traverse the muscle completely and become cutaneous where they anastomose with the ramifications of the cutaneous branch of the axillary.

PHYSIOLOGY

The *teres minor* muscle has an analagous action to the *infraspinatus*. It rotates the head of the humerus outward.

The *deltoid* muscle abducts the arm from the side to a right angle with the trunk. As it performs this function the vertebral border of the scapula stands out from the wall of the thorax. If the arm is abducted vigorously all of the fibers of the deltoid contract. When the arm is drawn forward or inward the posterior fibers relax.

SURGERY

Isolated lesions of the axillary nerve are comparatively rare so that the nerve is usually affected by injuries to the upper part of the brachial plexus. Because of its short course, its repair is quite difficult and in the event of a continuity defect an end-to-end suture is practically impossible. Dislocations of the shoulder, particularly those which are anterior and inferior in direction may seriously traumatize the nerve.

If the nerve is injured in the axilla surgical exposure is obtained in much the same manner as in lesions of the plexus. The arm is strongly abducted and rotated outward. An incision is made over the course of the neurovascular bundle from the middle of the clavicle to the tendon of the *pectoralis major* muscle (Fig. 219). The *deltoid* and *pectoralis major* are

separated and the pectoralis major fascia is exposed. The tendon of the latter muscle may then be retracted. The deep pectoral fascia is divided to expose the neurovascular bundles.



FIG. 219. Line of incision to expose axillary nerve.

The median nerve and axillary artery are identified and retracted medially. This will expose the radial nerve as it passes over the tendon of the latissimus dorsi. This nerve should be followed upward and near the insertion of the pectoralis minor muscle, the axillary nerve will be found in close relation to the radial. The axillary may then be traced around the medial side of the neck of the humerus to the point where it enters the quadrilateral space.

If the axillary nerve is injured as it passes around the surgical neck of the humerus, a dorsal or laterally placed incision is necessary for an exposure. The patient should lie upon his side with the arm acutely flexed. This will afford access to the posterior deltoid region. A longitudinal incision should be made along the dorsal border of the deltoid muscle. The muscle should be elevated and retracted anteriorly. This procedure may be facilitated by elevating the arm so that the deltoid is relaxed. Occasionally it may be necessary to divide some of the deltoid fibers to isolate the nerve as it emerges from the quadrilateral space to wind about the neck of the humerus.

CHAPTER XXVII

THE MUSCULOCUTANEOUS NERVE

The musculocutaneous nerve is rarely injured alone by gunshot or stab wounds. It is commonly involved in brachial plexus lesions. Paralysis may likewise result from concomitant fracture of the humerus and callus formation. It has been observed after dislocation of the humerus. Occasionally it has been the seat of a mononeuritis.

MOTOR SYMPTOMS

Evidence of paralysis of this nerve may be determined by palpation of the biceps muscle when flexion of the forearm is resisted with the forearm in position between pronation and supination (Fig. 220). It may be detected also by observing absence of normal contraction of the biceps upon voluntary movements and its failure to contract to the faradic current.

SUPPLEMENTARY MOVEMENTS: Although supplementary motility permits of all the movements ordinarily assisted in by the muscles supplied by the musculocutaneous nerve, they are naturally reduced in strength. The biceps supinates as well as flexes the forearm, while the brachialis anticus is a pure flexor. In paralysis of the musculocutaneous satisfactory flexion can be produced by the voluntary action of the brachioradialis which is supplied by the radial nerve. The pronator radii teres is also a flexor of the forearm and in some cases has efficiently produced flexion in combined paralysis of the musculocutaneous and radial nerves.

SENSORY SYMPTOMS

The sensory loss is observed over the radial side of the volar surface of the forearm (Fig. 221). At times the loss to tactile sensibility is wide, yet because of overlap from the medial cutaneous and radial nerves there is a considerable zone within the borders of this area where pain is felt.

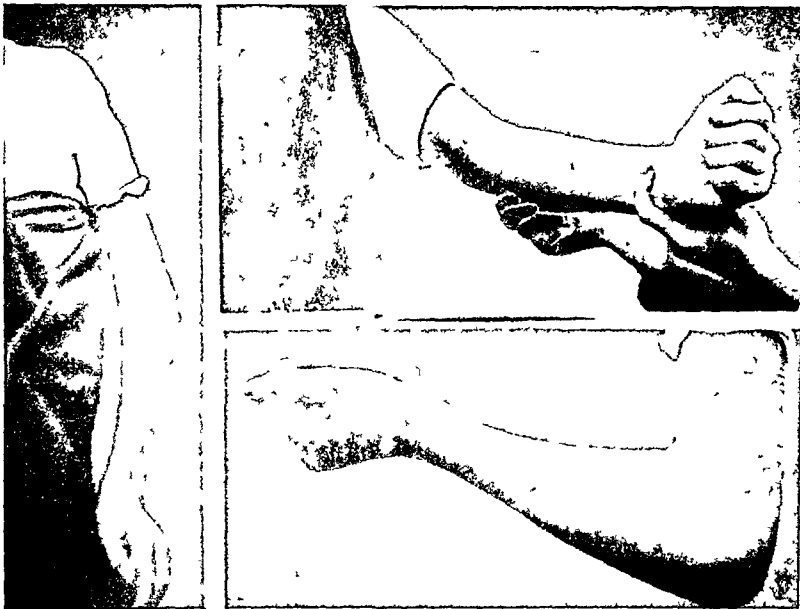


FIG. 220. Paralysis of the biceps muscle in musculocutaneous nerve paralysis.

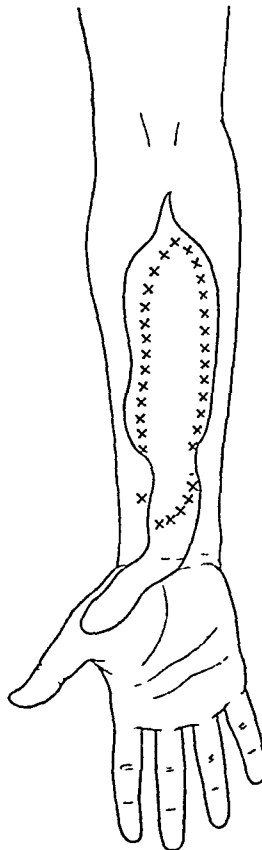


FIG. 221. Sensory loss in musculocutaneous nerve lesion.

SIGNS OF RECOVERY

Recovery appears in all the muscles simultaneously, and sensory regeneration goes hand in hand with motor.

ANATOMY

The musculocutaneous nerve arises from the lateral cord of the brachial plexus. Therefore, it receives fibers from the anterior divisions of the fifth and sixth cervical spinal nerves. It has an origin in common with the lateral head of the median nerve. With the exception of the medial cutaneous nerves to the arm and forearm it is the smallest terminal branch of the brachial plexus. At its origin it is in contact with the axillary artery but soon descends externally and anteriorly, leaving the neurovascular bundle medial and posterior to it. The nerve perforates the coracobrachialis muscle between its two heads and then lies between the brachialis anticus and biceps muscles. It reaches the external bicipital groove, pierces the aponeurosis and divides into its two terminal branches which course along the radial surface of the forearm to end on the dorsal surface of the wrist at the base of the thenar eminence.

The musculocutaneous arises from the brachial plexus beneath the pectoralis minor muscle though it may arise more peripherally, almost as a branch of the median. It lies anterior to the subscapularis muscle and parallels the lateral border of the third portion of the axillary artery. The lateral head of the median nerve lies upon the artery and the other branches of the plexus lie anterior to the musculocutaneous. As the latter leaves the vessel it crosses the circumflex vessels, and pierces the coracobrachialis in an oblique canal formed by the two heads of origin of the muscle. The canal is at the level of the tendon of the latissimus dorsi. Occasionally the musculocutaneous may not lie in this canal but may pass either external

or medial to the muscle. After passing between the brachialis anticus and biceps to reach the external bicipital groove it penetrates the aponeurosis at a variable point above the elbow. Regardless of this exact site the nerve becomes subcutaneous medial to the cephalic vein. It divides into its terminal cutaneous branches at this level, where it may also anastomose with the external cutaneous branch of the radial, which perforates the aponeurosis external to the cephalic vein (Fig. 222).

Just below the origin of the nerve it gives off *periosteal rami* which supply the humerus.

Vascular branches, variable in number, supply the walls of the inferior part of the axillary and all of the brachial artery. Exceptionally the nerve may give twigs to the beginning of the radial artery.

As the musculocutaneous enters the canal between the two heads of origin of the *coracobrachialis* muscle it gives off a branch to that muscle. Though this branch runs directly with the musculocutaneous and usually is incorporated within its sheath, it is actually a distinct nerve. It receives its fibers from the anterior divisions of the seventh cervical spinal nerve.

Many times each head of the *biceps* receives two or three twigs which originate directly from the trunk of the musculocutaneous, but more often these various twigs arise within a common trunk which may appear to be a bifurcation of the musculocutaneous. This trunk may arise from the musculocutaneous as it descends obliquely between the biceps and brachialis anticus. After a short course the trunk then divides into two branches whose ramifications form a plexus. One of these branches supplies the long head and another the short head of the biceps at a level just below the middle of the arm.

The nerves to the *brachialis anticus* may be four or five in number, which arise from the musculocutaneous by a common trunk.

A small articular *ramus to the elbow joint* may be given off either from the branch to the biceps or from that to the

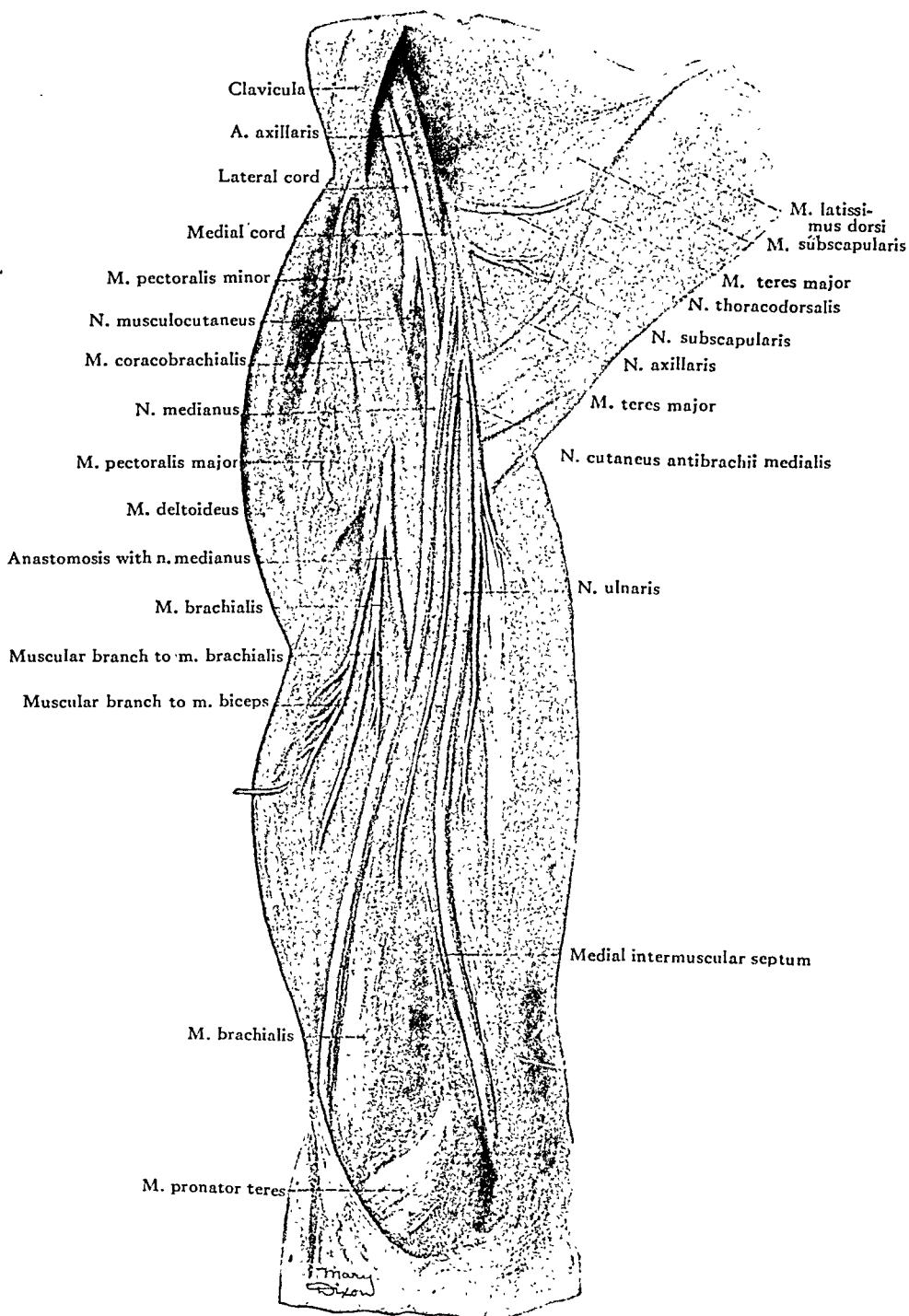


FIG. 222. Anatomical course of musculocutaneous nerve.

brachialis anticus. This articular ramus supplies the medial part of the anterior surface of the capsule of the joint.

The terminal branches of the musculocutaneous are entirely cutaneous in function. Of these two branches, one lies anterior and medial while the other is posterior and lateral. As they descend in the forearm they cross the medial cephalic vein. Occasionally one branch may lie anterior and the other posterior to the vein.

The anterior and medial branch is the larger of the two and courses along the anterior surface of the radial half of the forearm. In its course it gives off many collateral branches at an acute angle, which pass across the median line and anastomose with collaterals from the internal cutaneous nerve to the forearm. Other collaterals pass laterally to anastomose with twigs from the posterior and lateral branch. The anterior and medial cutaneous branch ends by supplying the skin over the thenar eminence. The posterior and lateral cutaneous branch descends upon the lateral side of the posterior surface of the forearm. It terminates on the dorsal surface of the inferior part of the forearm in the region of the anatomical snuff-box.

Many types of anastomosis and anomalies of distribution occur between the median and musculocutaneous nerves. As was pointed out, the origin of the lateral head of the median and the musculocutaneous is the same. It is only in higher mammals that the two nerves are not represented by a single trunk. In man the median nerve may take over the entire motor and sensory supply of the musculocutaneous.

Some type of communication between the two nerves occurs in about 7 per cent and the variations may depend upon the type of brachial plexus; that is, whether it is prefixed or postfixed. Stookey states that fibers pass from the musculocutaneous to the median nerve more often in the postfixed plexus, perhaps because the fifth and sixth cervical roots contribute less to the median nerve than they do in the prefixed plexus. In the latter type of plexus the communication may be reversed.

PHYSIOLOGY

The *coracobrachialis* muscle keeps the head of the humerus firmly within the glenoid cavity as the arm is lowered. An isolated paralysis of this muscle is difficult to detect.

The *brachialis anticus* produces forceful flexion of the forearm without any other movement. It is therefore an independent flexor of the forearm.

The biceps flexes and supinates the forearm. According to Duchenne the movement of supination is due rather to the short than to the long head of the biceps.

SURGERY

In the upper part of its course lesions of the musculocutaneous are usually associated with injury to the neurovascular bundle. If the nerve is injured in the lower third of the arm, the motor fibers usually escape involvement.

In the axilla the nerve may be exposed by a long incision which follows the medial border of the coracobrachialis muscle. It begins a few centimeters below the clavicle and extends to the middle of the arm. The coracobrachialis is exposed by division of the deep fascia. The pectoralis major and deltoid are separated and the deep pectoral fascia is exposed. The cephalic vein should be preserved in this situation. The pectoralis major tendon should be divided and retracted medially. The median nerve may be isolated by dividing the pectoral fascia covering the neurovascular bundle. The median should be followed upward and its lateral and medial heads identified. The musculocutaneous may then be isolated as it lies lateral to the median's external head and before it enters the canal in the coracobrachialis muscle.

A lesion to the nerve below the coracobrachialis is exposed by a longitudinal incision over the upper portion of the biceps. The two heads of this muscle should be separated. In this recess the nerve will be found as it lies on the coracobrachialis.

Occasionally certain lesions necessitate exposure of the cutaneous terminal branches of the nerve and often it is utilized for an autogenous graft. The incision extends along the medial edge of the brachioradialis muscle. The nerve will be found emerging from beneath the lateral edge of the biceps. It may be followed upward by retracting the biceps medially. Continuity defects in the musculocutaneus may be partly overcome by flexion and adduction of the arm. If the pectoralis major tendon has been divided it should be carefully sutured and the arm maintained in flexion and adduction.

CHAPTER XXVIII

SHOULDER GIRDLE NERVES

The long thoracic is a purely motor nerve and supplies the serratus magnus muscle. In civil practice paralysis of this nerve is commonly observed as an isolated lesion, but it also occurs frequently in association with paralysis of the trapezius, rhomboids, spinati and other muscles. It occurs more frequently in men, usually laborers, and in muscular individuals between the ages of twenty-five to forty-five years. The right side is most frequently affected, and it is usually injured unilaterally. The injury occurs as a result of trauma from the strain of prolonged and excessive use of the muscle in carrying heavy weights, or the use of a hammer; from continued elevation of the arms, as in painting, cleaning walls and from direct injury from puncture or gunshot wounds. The nerve may be injured during the extirpation of diseased glands and other operative procedures. Mononeuritis has often been described as affecting this nerve. In the war a few cases of isolated paralysis were described.

Contraction of the serratus magnus muscle results in carrying the scapula forward, outward and upward. It contracts vigorously in conjunction with the pectoralis major in the act of pushing the point of the shoulder forward. Its action in supplementing the deltoid in abduction of the arm has been described.

When paralyzed, the position of the scapula when at rest is not abnormal. Upon attempting to raise the arm to the horizontal there is a characteristic "winging" of the scapula (Fig. 223). The anterior aspect of the scapula leaves the thorax and the vertebral borders stand away prominently from the middle line. Although it is an important muscle in abduction of the arm, according to Steiner who, in 1900, analyzed the cases which occurred in the German army, the remaining

intact muscles are sufficient to permit abduction of the arm above a right angle in 95 per cent of the cases. Complete elevation of the arm to 180 degrees was, however, defective.

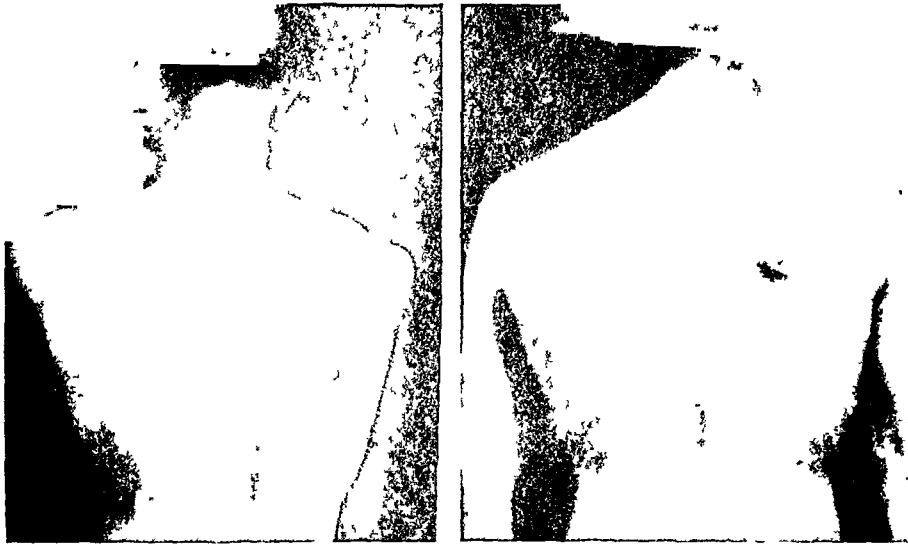


FIG. 223. Deformity of "winged" scapula in serratus muscle paralysis.

In a certain number of cases the arm can not be elevated much above the right angle unless the scapula is passively immobilized against the chest wall.

The other nerves which supply the muscles of the shoulder girdle, *dorsalis scapulae* (rhomboids and levator anguli scapulae); the anterior thoracic nerves (*pectoralis major* and *minor*); *suprascapular* (*suprascapularis* and *infraspinatus*); *subscapularis* (*subscapularis*); and the *thoracodorsalis* (*latissimus dorsi*) are injured alone so rarely that their function only will be described so that when their injury is noted in the chapter on brachial plexus lesions the resulting disability may be understood.

The *dorsalis scapulae* nerve supplies the rhomboids and the levator anguli scapulae. The former muscles hold the scapula upward toward the midline, approximating the inferior angle to the vertebral column, while the internal angle is drawn away from it. When the shoulder is raised energetically the

rhomboid comes into active function. When paralyzed, the groove between the scapula and the chest wall becomes deeper and it is difficult to draw the arm backward and out-

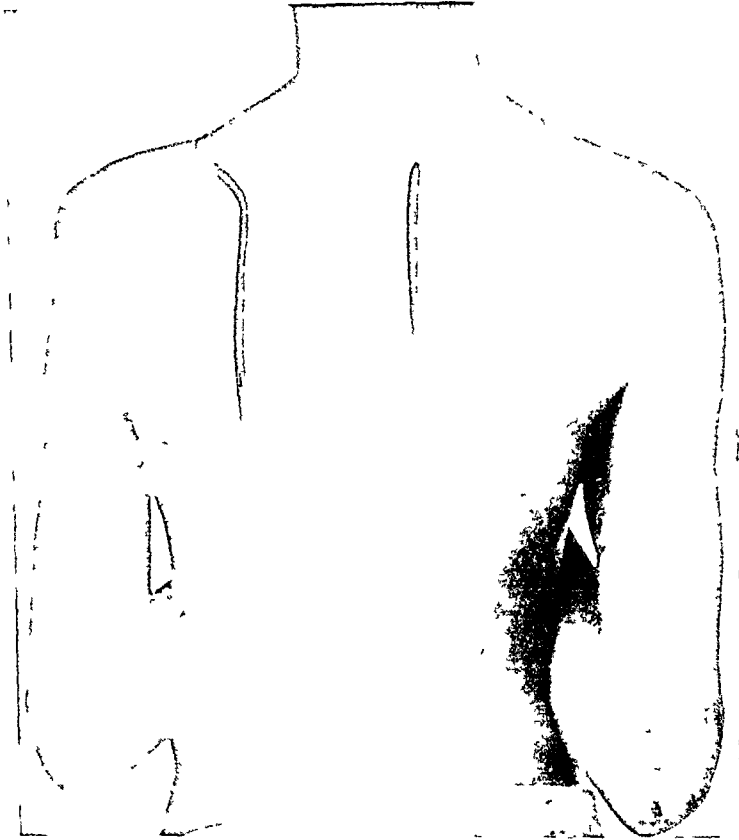


FIG. 224. Paralysis of rhomboids and infraspinatus muscles.

ward (Fig. 224). The levator anguli scapuli raises and rotates the superior angle of the scapula inward, drawing the point of the shoulder with it. It contracts forcibly on coughing, and its paralysis may readily be ascertained by its failure to contract during that act.

When both latissimi dorsi muscles contract the shoulders take the position of a soldier at attention. Their function may be tested by having the patient place his hand as if in a hip

pocket on the affected side, and to resist attempts to draw the arm forward.

The anterior thoracic nerves supply the pectorals which, when contracted, adduct and bring the arm forward. The upper portion draws the point of the shoulder upward and forward. With the arm in a vertical position it draws the shoulder forward toward the midline and depresses it to the horizontal. Attempts passively to abduct the adducted upper extremity in a horizontal position produce a contraction of the muscles which may readily be felt and seen.

The anatomy, physiology and surgery of these nerves, which are collateral branches which arise from the constituent roots of the brachial plexus before the lateral, medial and posterior cords are formed will be described in the following chapter upon the brachial plexus.

CHAPTER XXIX

THE BRACHIAL PLEXUS

We have become accustomed to a simple classification of brachial plexus lesions in civil practice. This has been possible because the majority of injuries, occurring either as the result of trauma at birth or trauma produced by dislocation of the humerus and traction of the plexus, have produced lesions of certain parts of the plexus in a constant manner peculiar to the particular injury. Such injuries have been classified as complete and incomplete. Of the incomplete forms the upper brachial plexus paralysis, or Erb's palsy, has been the most frequent. This is produced by a lesion of the fifth and sixth cervical roots, and results in a paralysis of the deltoid, biceps, brachialis anticus, brachioradialis, occasionally the supinator brevis and the infraspinatus and, less frequently, the subscapularis muscles (Fig. 225). Klumpke's palsy, or lower brachial plexus paralysis, has been found less frequently. This results from a lesion of the eighth cervical and first dorsal roots and produces a paralysis of the muscles supplied by the ulnar nerve and the inner head of the median nerve (Fig. 226).

Lesions of the secondary cords have been encountered far less frequently. Injury to the outer cord of the plexus produces a paralysis of the muscles supplied by the musculocutaneous nerve and the outer head of the median. Injury of the posterior cord results in paralysis of the muscles supplied by the radial and axillary nerves, and injury to the inner cord results in paralysis of the muscles supplied by the ulnar and the inner head of the median nerve. There is a temptation and tendency to ignore that which does not fit in with a preconceived and accepted simple classification. Even in civil practice, it is common to find a lesion at first affecting the whole brachial plexus which later resolves itself into a more or less permanent injury to a part of the plexus (Fig. 227).

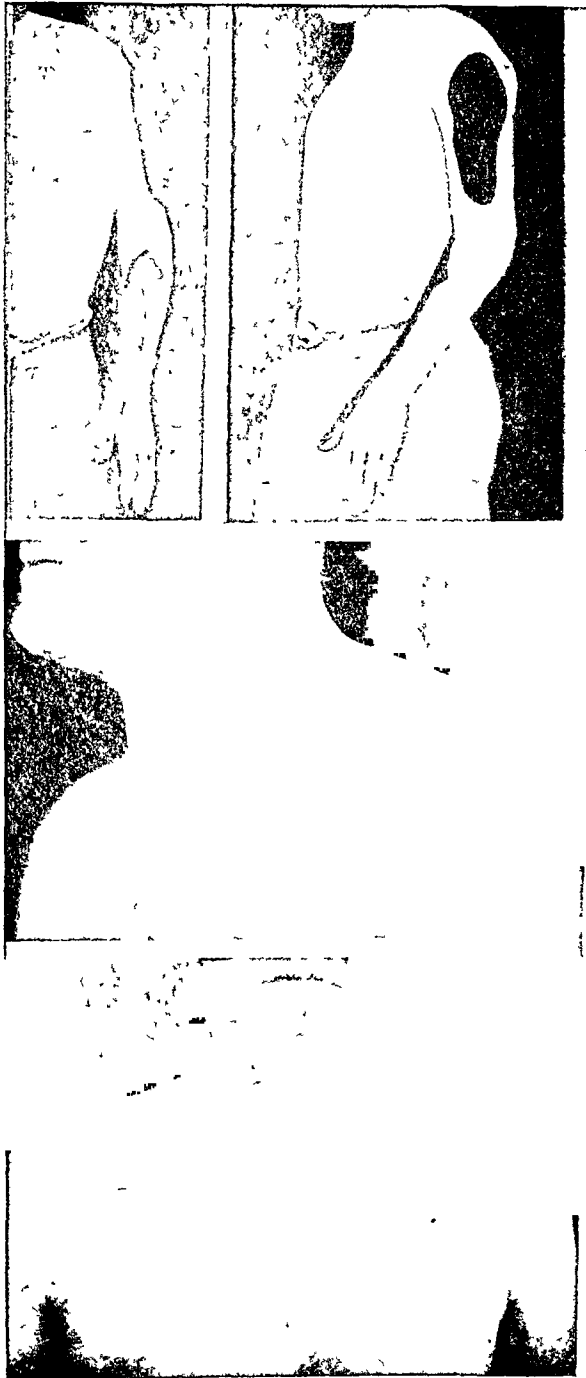


FIG. 225. Upper brachial plexus paralysis.

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In civil practice injury to the brachial plexus may occur in operative procedures upon the neck and axilla, and anesthetic and sleep palsy have been observed. However, more frequently

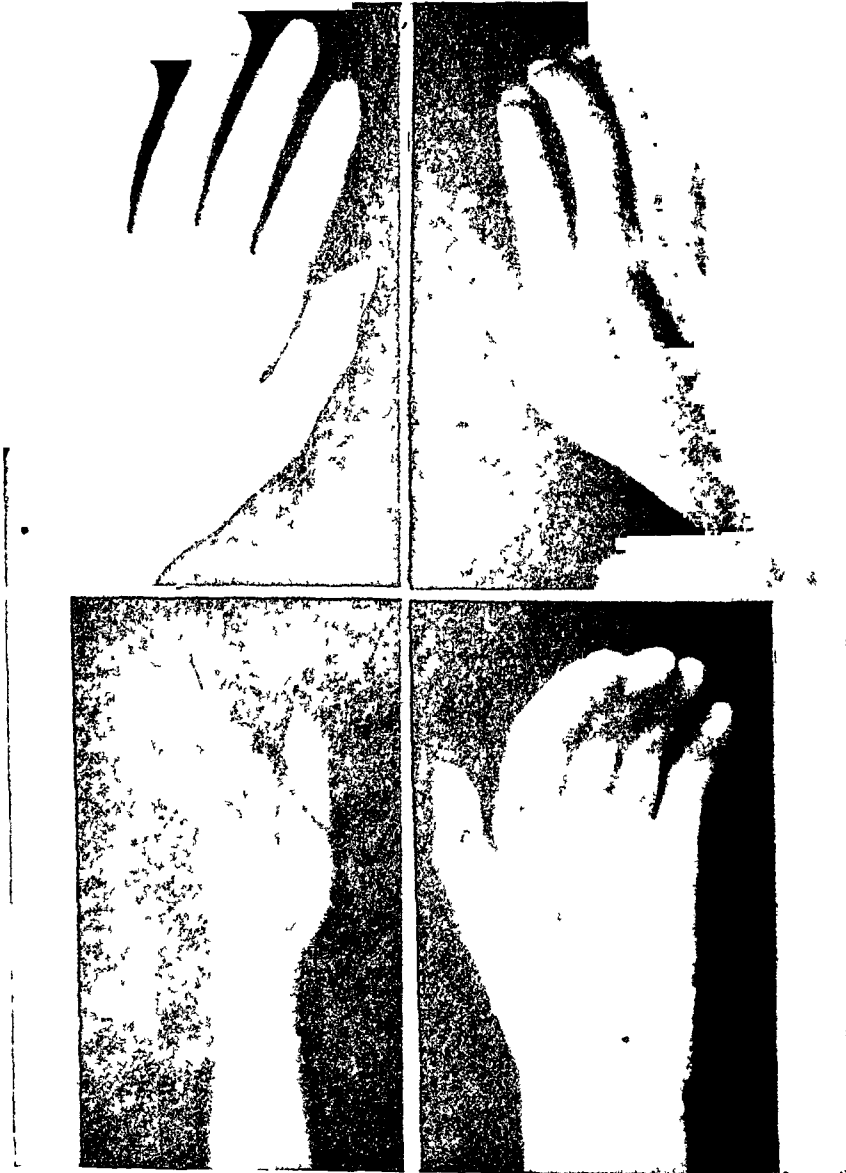


FIG. 226 Lower brachial plexus paralysis.

it is injured at birth. Dislocation and fracture of the humerus; pressure of the heel in the axilla in reducing dislocations; direct

violence in the posterior cervical triangle; cervical ribs; osteoarthritis of the spine; and compression by tumors may produce paralysis. Sudden strong abduction of the arm and force

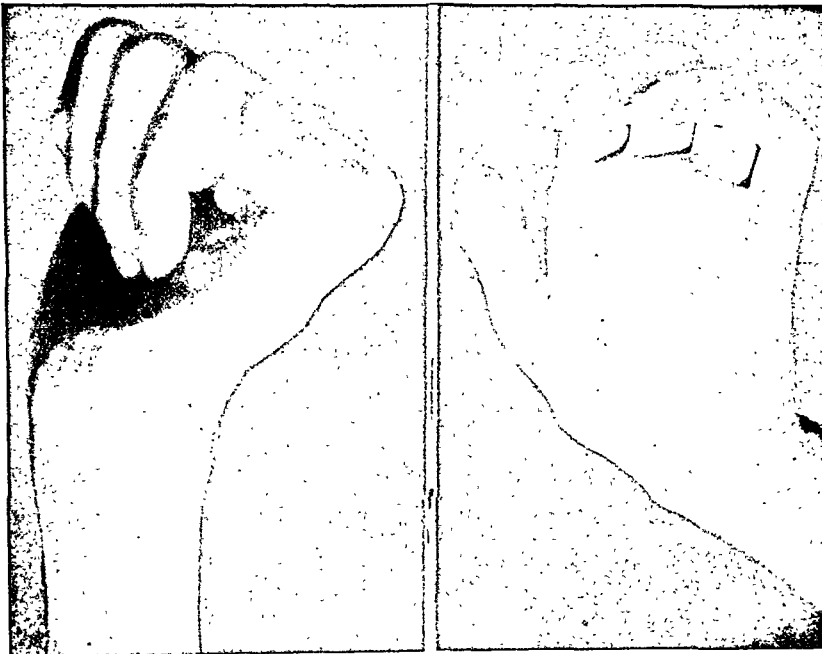


FIG. 227. Residual paralysis following partial lesion of entire brachial plexus.

transmitted to an outstretched arm, as well as traction on a hanging arm, may also injure it.

Gunshot injuries of the brachial plexus occurred in large numbers in the late war. The statistics vary considerably. Purves-Stewart found 61 such cases, or 19 per cent, in 318 peripheral nerve injuries. Lehmann found 37, or 7.5 per cent, in 494 peripheral nerve injuries. Oppenheim in a series of 1612 cases found 84, or 5 per cent. In our series of 1020 cases, there were 79, or 7.7 per cent.

Inasmuch as the lesions of the brachial plexus which result from gunshot injuries have a tendency to recover spontaneously, there is considerable difference in incidence between the observations at the front and those in general hospitals where the material is seen some time after injury.

In military practice, injuries to the brachial plexus do not lend themselves so readily to a simple classification. Gunshot wounds produce injuries the extent of which is dependent upon the course of each particular missile and are so variable that there may be a lesion of roots, and primary or secondary cords, in a single case. Furthermore, the initial trauma is followed by changes secondary to hemorrhage, infection and fibrosis. In addition to variable injuries, the numerous and wide variations in the formation of the brachial plexus, as described by Borchardt, are responsible for atypical paralyses.

Anatomically the lesions may be grouped into supraclavicular and infraclavicular. It is striking that in 23 available and competent records of 44 cases seen in base hospitals in France, all were supraclavicular. This is in part explained by the fact that infraclavicular lesions, commonly due to injuries in the axilla, were complicated by injuries to bones and vessels which made the neurological aspect less urgent, and because of the necessary splints and dressings frequently led to misinterpretations. For example, a diagnosis of a combined ulnar and median nerve lesion was usual instead of a lower brachial plexus lesion.

In a series of 35 cases observed in a general hospital a number of months after injury, there were 22 infraclavicular and 13 supraclavicular lesions. In the overseas cases there were only 3 lower plexus injuries; in those seen in the United States there were 12. Inasmuch as it has been found that lesions of the lower plexus are more frequently irrecoverable, the explanation is apparent.

Although it has been stated (Souttar) that supraclavicular and infraclavicular lesions produce injury of the roots and cords respectively this was not found to be true. However, supraclavicular injuries apparently produce lower brachial lesions but rarely. An upper brachial lesion is most commonly produced, although middle plexus lesions occur frequently. Infraclavicular injuries produce lower plexus paralysis most frequently, but middle plexus paralysis is likewise common.

The cases may be most readily grouped into those which show an upper, middle or lower plexus paralysis. The upper plexus paralysis includes lesions of the fifth cervical nerve; the upper primary trunk (fifth and sixth cervical); and a combination of the upper primary trunk and a diffuse lesion of the middle plexus. The middle plexus lesions are produced by injury to the posterior branches alone (radial and axillary); to the posterior secondary cord or to the posterior and outer cord. In lower plexus paralysis there may be a lesion of the inner secondary cord alone, or combined with a partial middle plexus lesion; or of the peripheral nerves, usually at a level below the complete formation of the median nerve but at times above that point. Finally, there may be an incomplete paralysis of the entire brachial plexus.

MOTOR SYMPTOMS

The complexity of the symptomatology may be seen from this far from simple classification. This complexity is better illustrated by diagrammatic representations of brachial plexus lesions which frequently show the impossibility of correlating the motor loss to any single lesion and lead only to an approximation of a localization. Operative exploration verifies the conclusion that although the greater part of an injury may be at one location, diffuse lesions occur elsewhere as well.

It has been found useful to employ diagrammatic representation of the location of an injury as described by Meige (Fig. 228). Two cases of upper brachial plexus lesions, due to injury of the fifth cervical nerve, are illustrated in Figure 229 and 230. Figure 229 represents the location of a lesion in a soldier who had a paralysis of the deltoid muscle and a paresis of the spinati and triceps muscles. Figure 230 is a diagram of the lesion which produced a paralysis of the deltoid muscle and a weakness of the spinati, pectoralis, latissimus dorsi, coracobrachialis, biceps and supinators.

Two other cases of upper brachial plexus lesions produced by an injury of the upper primary trunk are shown in Figures

231 and 232. In the case in Figure 231 there was a paralysis of the deltoid, spinati, biceps and brachialis anticus and a weakness in the subscapularis, supinators and the extensors

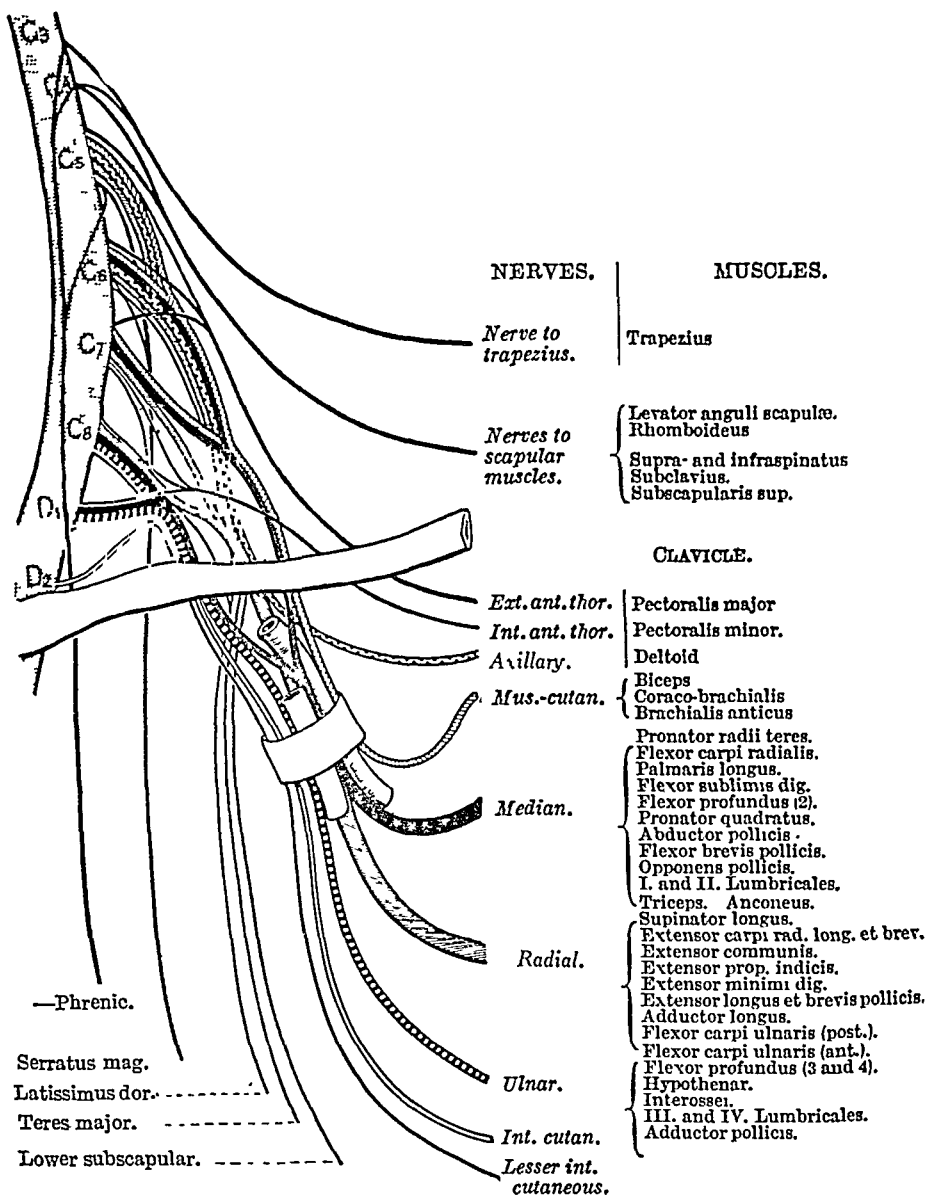


FIG. 228. Diagram of brachial plexus. (After Meigs.)

of the wrist. In Figure 232 the lesion is not as clearly defined and there was found a paralysis in the deltoid and spinati and

a weakness in the pectoralis, triceps, biceps, brachialis anticus, supinators and extensors of the wrists and fingers.

Two other cases of upper brachial plexus lesions of a more

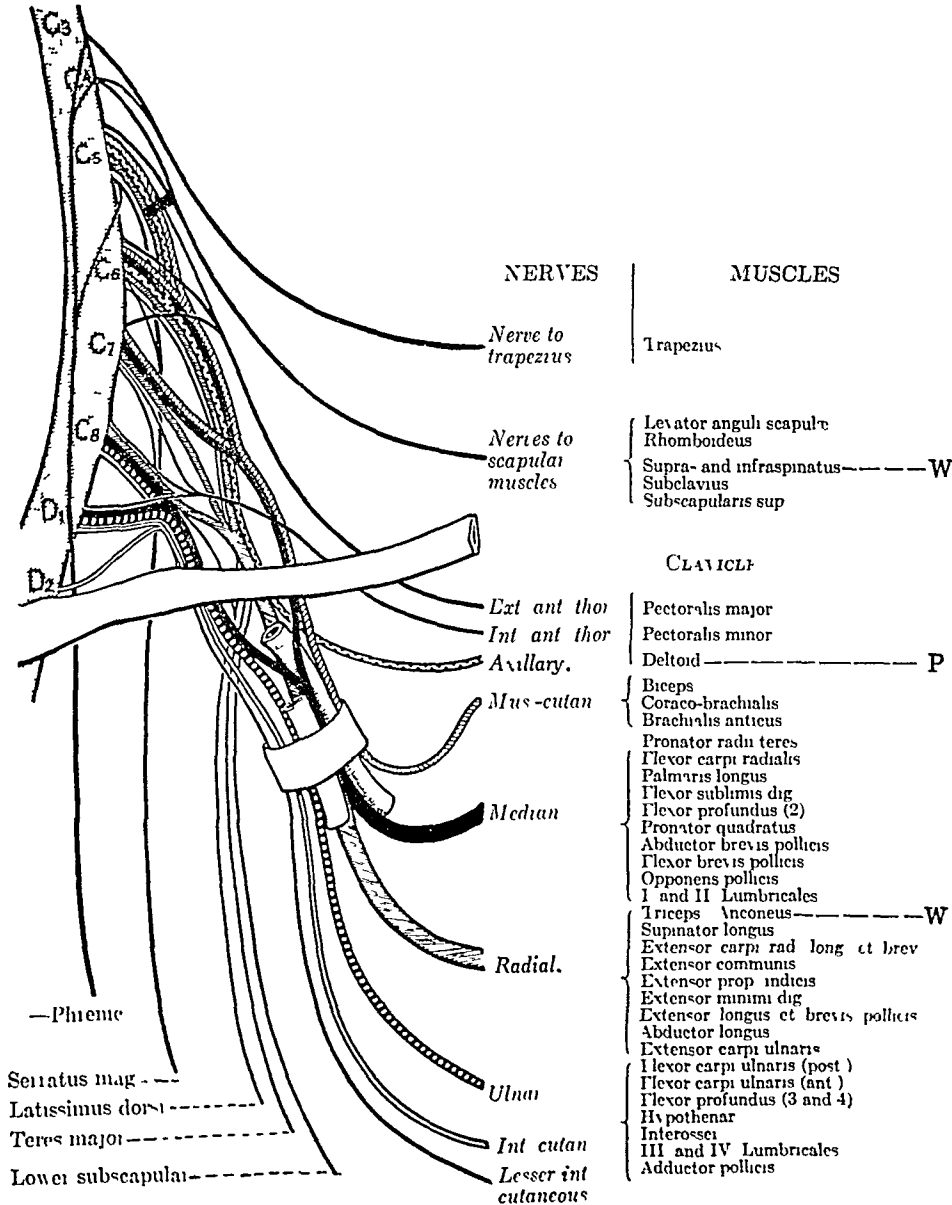


FIG. 229. Lesion of brachial plexus, described in text. w, weak. p, paralyzed.

complicated nature are illustrated in Figure 233 which represents the location of a lesion producing a paralysis of the

biceps, brachialis anticus, supinators and extensors of the wrists and fingers, and a weakness of the deltoid, spinati and triceps. In this instance there was an incomplete lesion of the

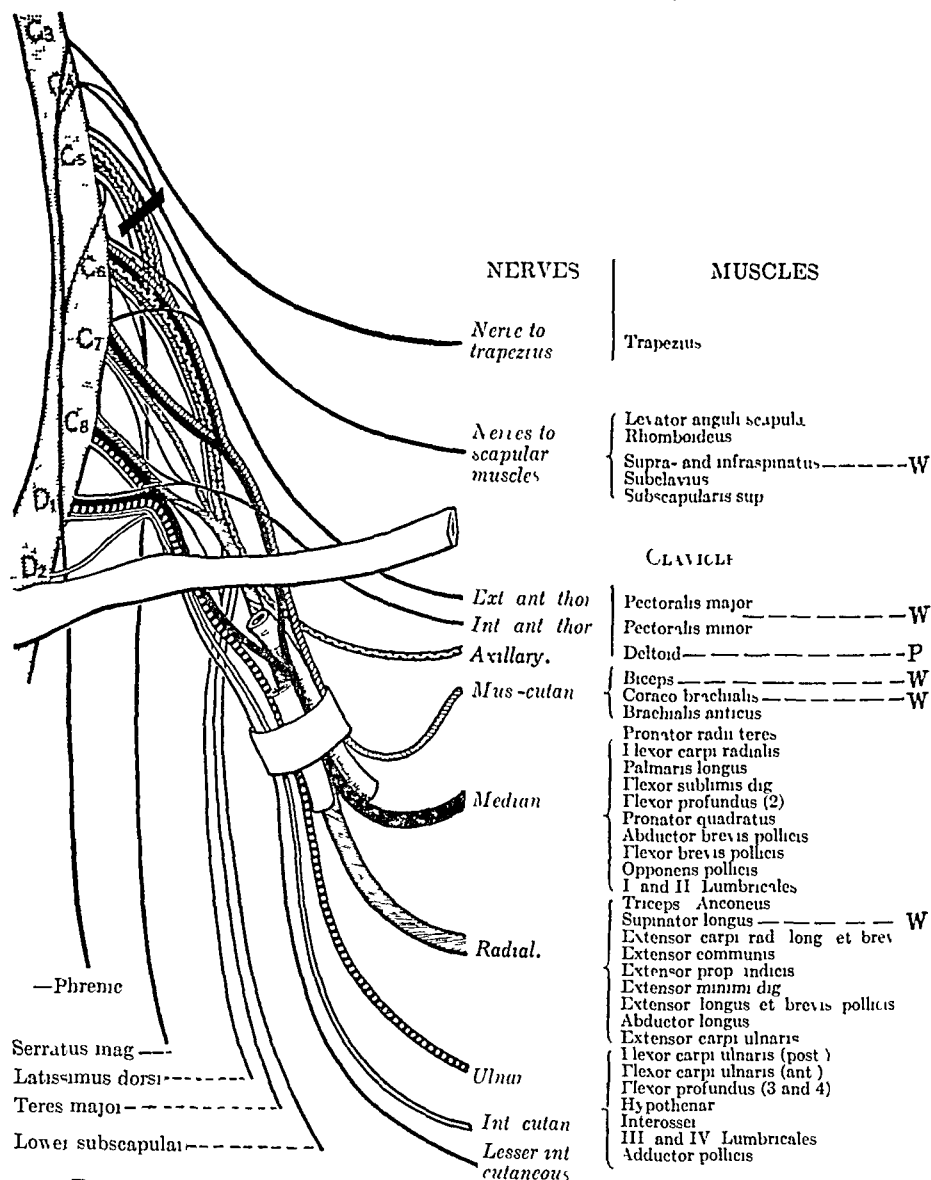


FIG. 230. Lesion of brachial plexus described in text. w, weak P, paralyzed

upper primary cord and a more severe one of the middle plexus. Figure 231 represents a case in which the upper plexus

was more severely injured and there resulted a paralysis of the deltoid, spinati, biceps, brachialis anticus, triceps, extensors of the wrist and fingers, supinators and pronators, flexor

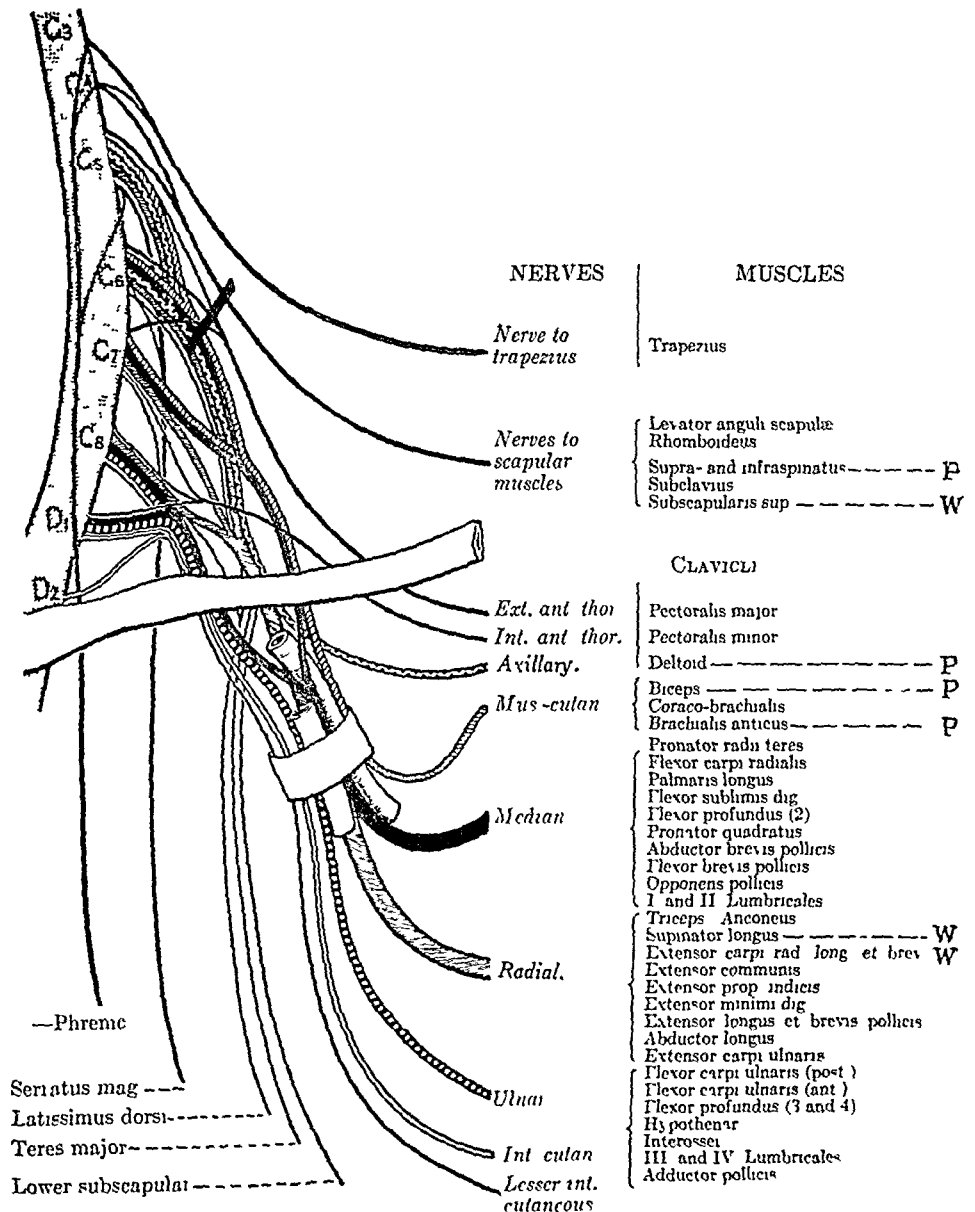


FIG. 231. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

longus pollicis, and a weakness of the flexor carpi radialis and opponens pollicis.

Although for practical purposes the foregoing cases could be divided into lesions of the cervical nerves, the upper primary cord and a combination of the upper primary cord and the

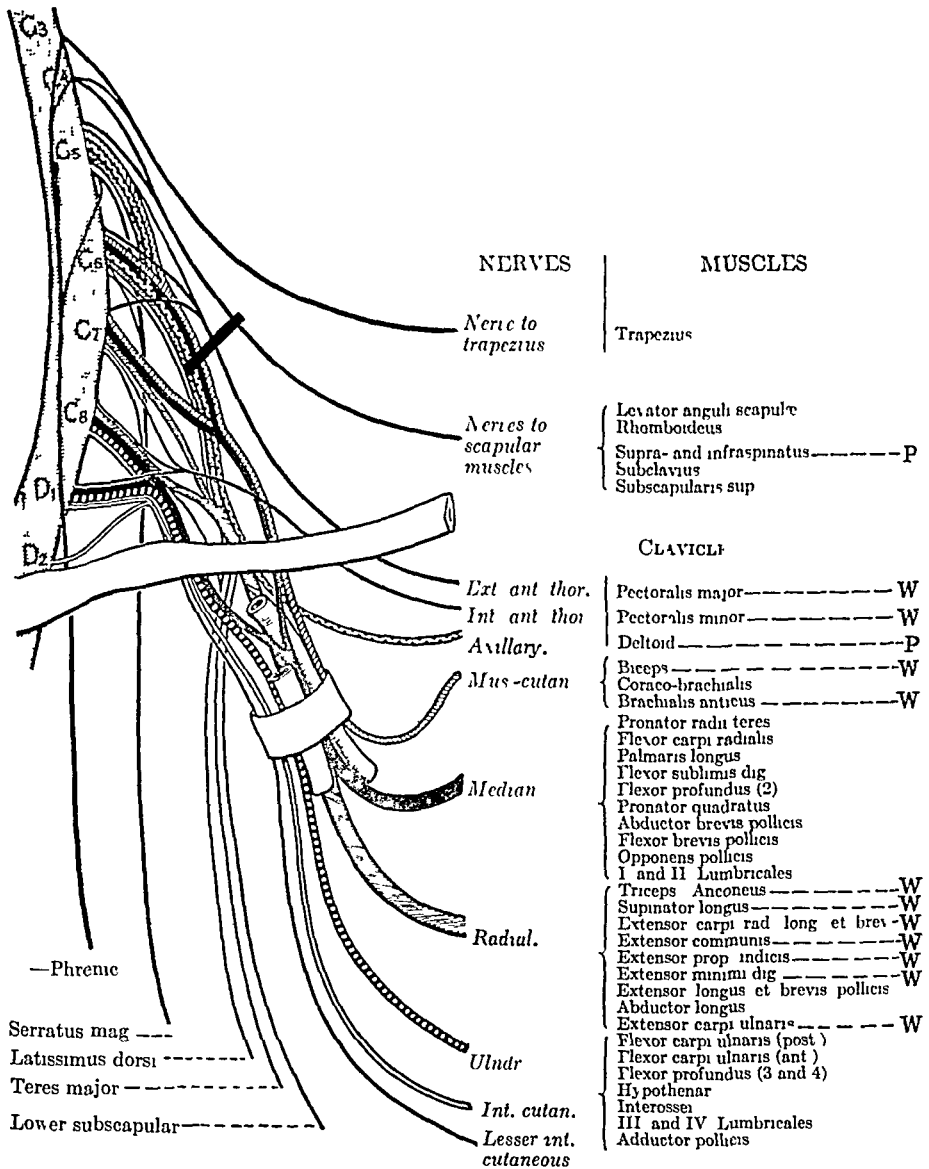


FIG. 232. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

middle plexus, it is apparent that none of the cases accurately corresponds to such a classification.

In contrast to the material of Oppenheim, few cases of relatively pure middle plexus lesions were seen. Frequently a severe lesion of the middle plexus was found combined with

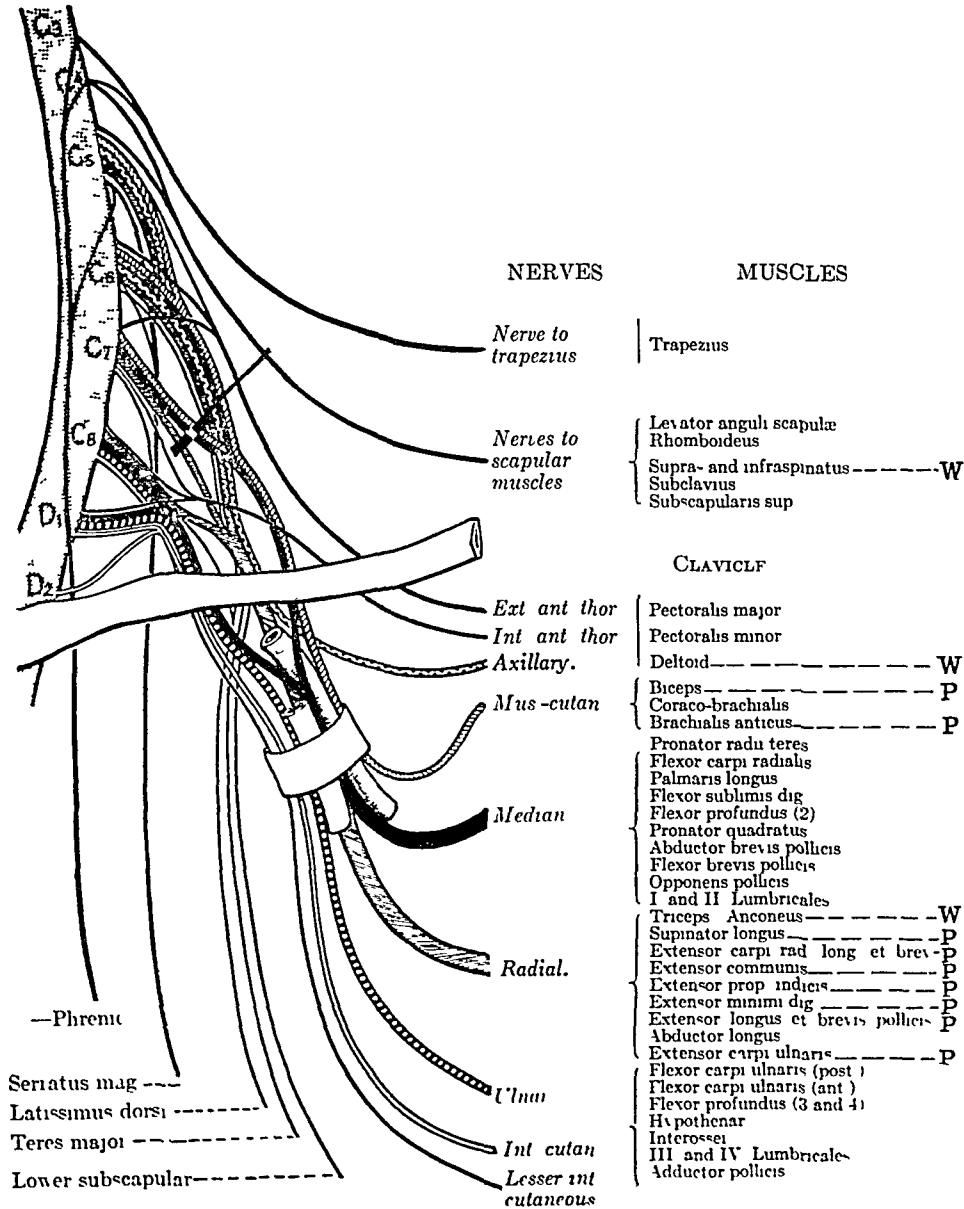


FIG. 233. Lesion of brachial plexus described in text. w, weak. p, paralyzed.

a partial lesion of the upper and lower plexuses, usually at the level of the secondary cords.

Figure 235 illustrates a middle plexus lesion produced by an injury to the posterior secondary cord. There was a paralysis of the deltoid, triceps, supinators, extensors of the wrist,

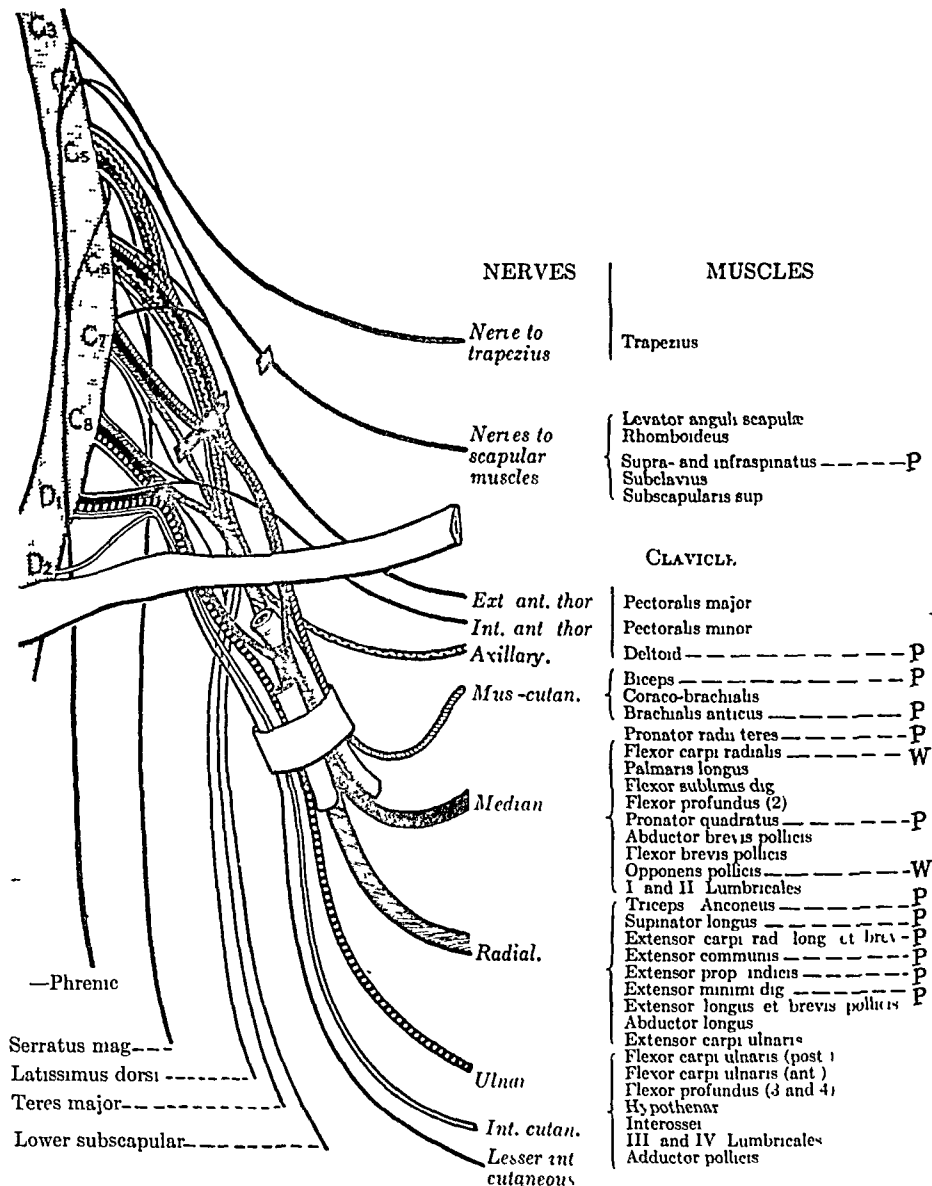


FIG. 234. Lesion of brachial plexus described in text. P, paralyzed. w, weak.

fingers and thumb and in addition a weakness in the biceps, lumbricales and opponens pollicis.

Figure 236 illustrates the combination of a posterior and outer secondary cord involvement. The deltoid, triceps, extensors of the wrist, fingers and thumb, the biceps, brachialis

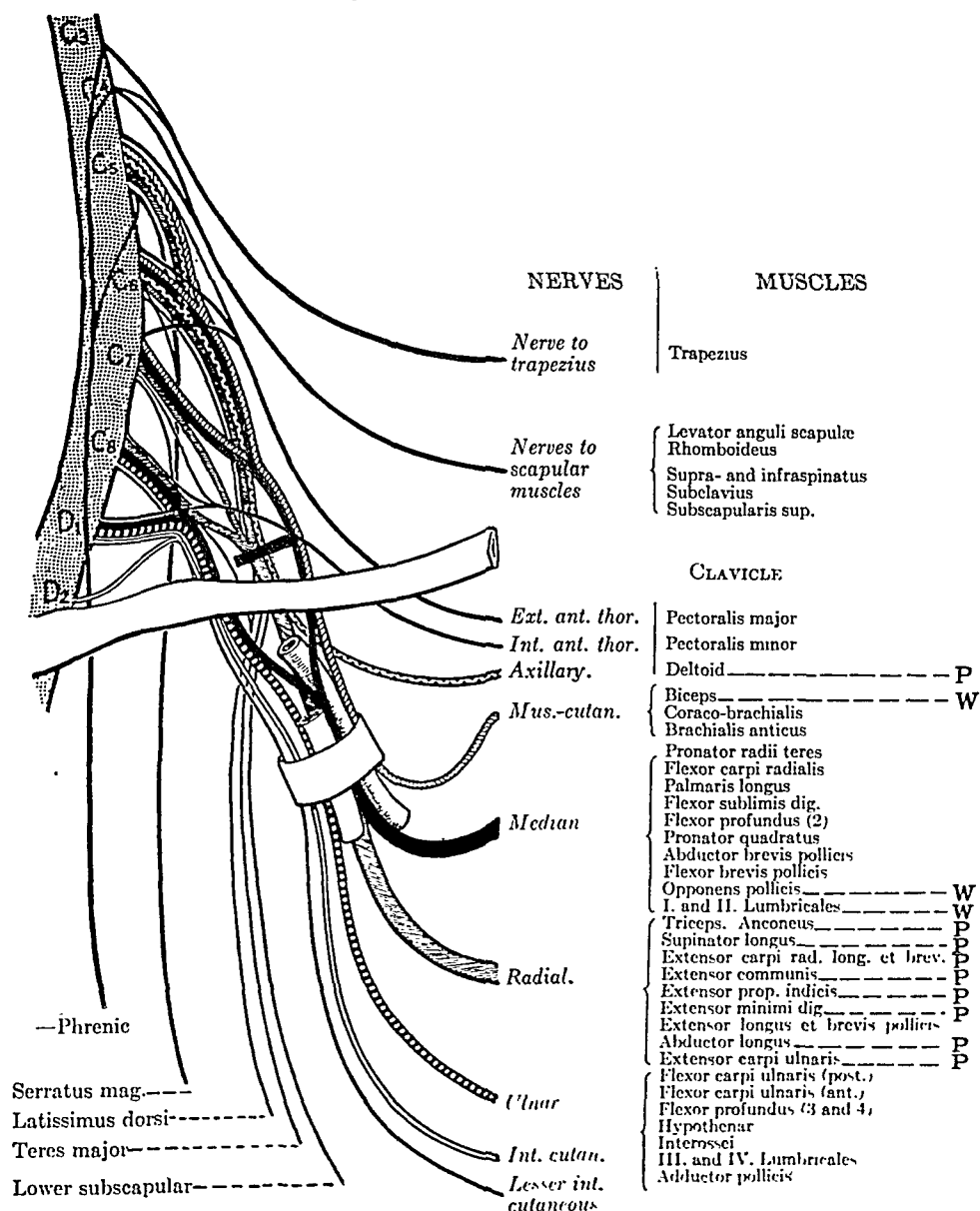


FIG. 235. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

anticus, the supinators, pronators, the flexor carpi radialis, and flexor sublimis digitorum were paralyzed. The pectorals and

latissimus dorsi were weak. Figure 237 represents a similar case. The deltoid, triceps, supinators, extensors of the wrist, fingers and thumb, biceps and brachialis anticus were paralyzed.

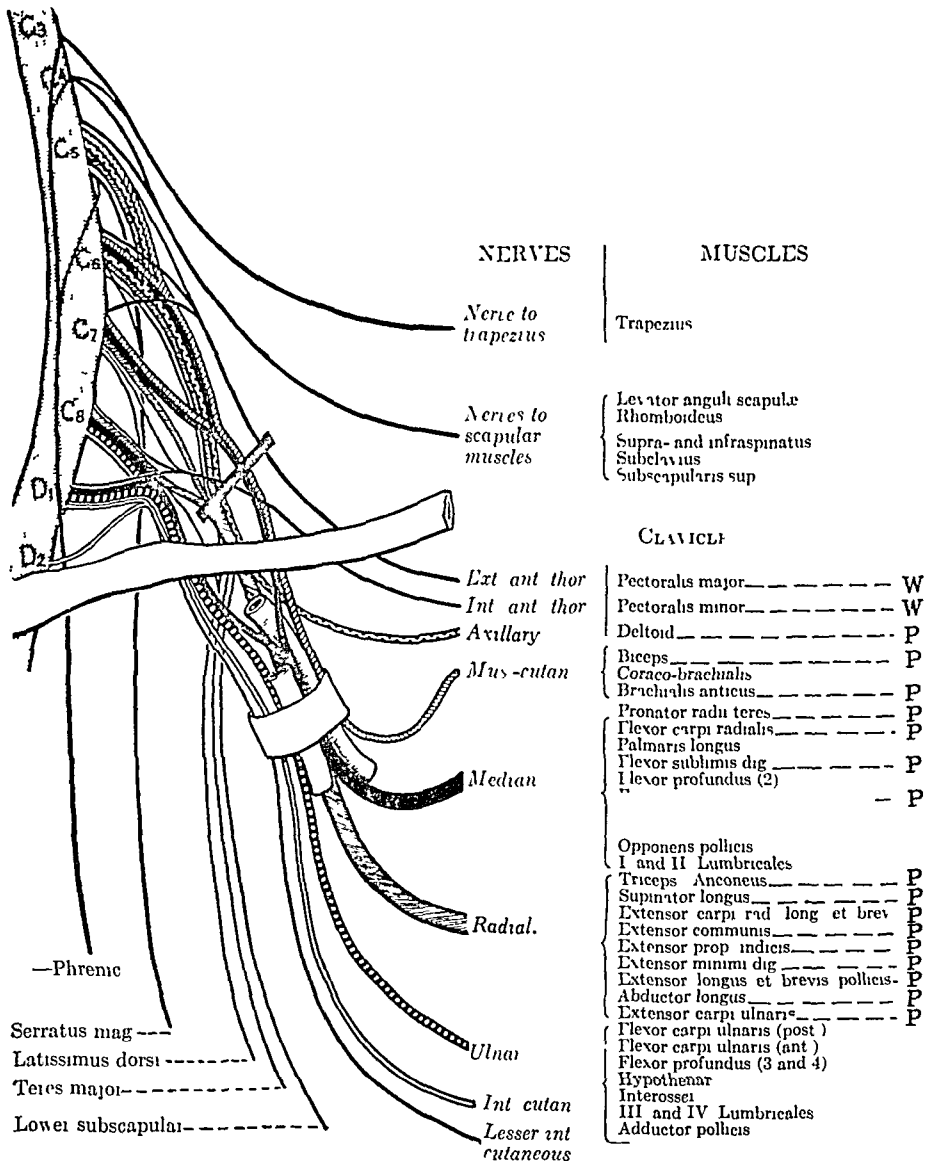


FIG. 236. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

Figure 238 shows an example of a partial lesion of the whole plexus, with a predominance of involvement of the

middle plexus. The extensors of the wrist, fingers and thumb, the interossei and lumbricales, serratus magnus, deltoid, pectorals, triceps, supinators, flexor carpi ulnaris, flexor sub-

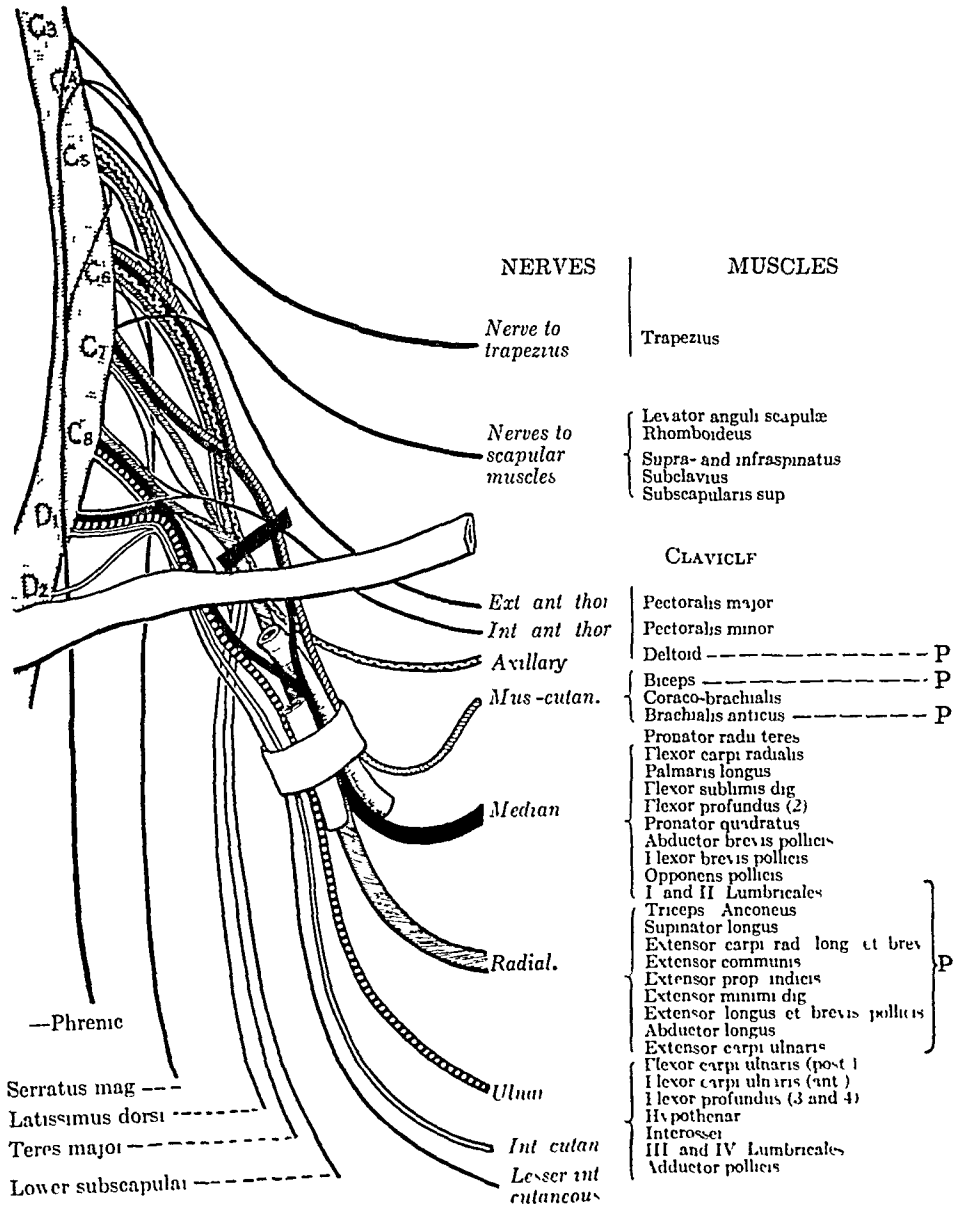


FIG. 237. Lesion of brachial plexus described in text. P, paralyzed.

limis and profundus digitorum, flexor brevis pollicis were paralyzed. The flexor longus pollicis and the thenar and hypo-

THE BRACHIAL PLEXUS

thenar muscles were weak. Figure 239 illustrates a similar case. There was a paralysis of all of the muscles supplied by the radial nerve and of the flexor carpi radialis, palmaris longus,

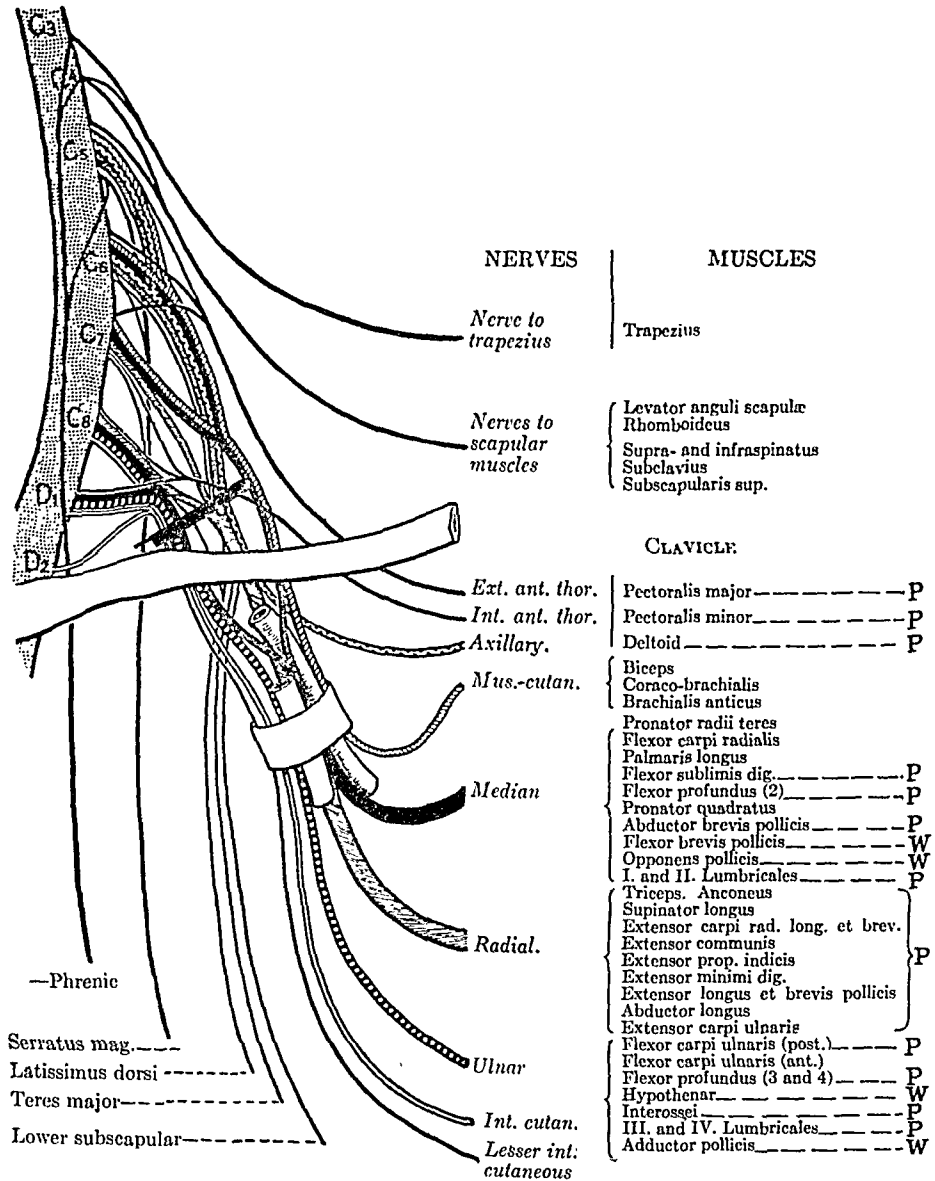


FIG. 238. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

the hypothenar muscles, pronators and abductors pollicis. There was weakness in the biceps, the brachialis anticus,

flexor carpi ulnaris, flexor sublimis and profundus digitorum, interossei, lumbricales, flexor longus pollicis and opponens pollicis. Figure 240 represents another somewhat similar case

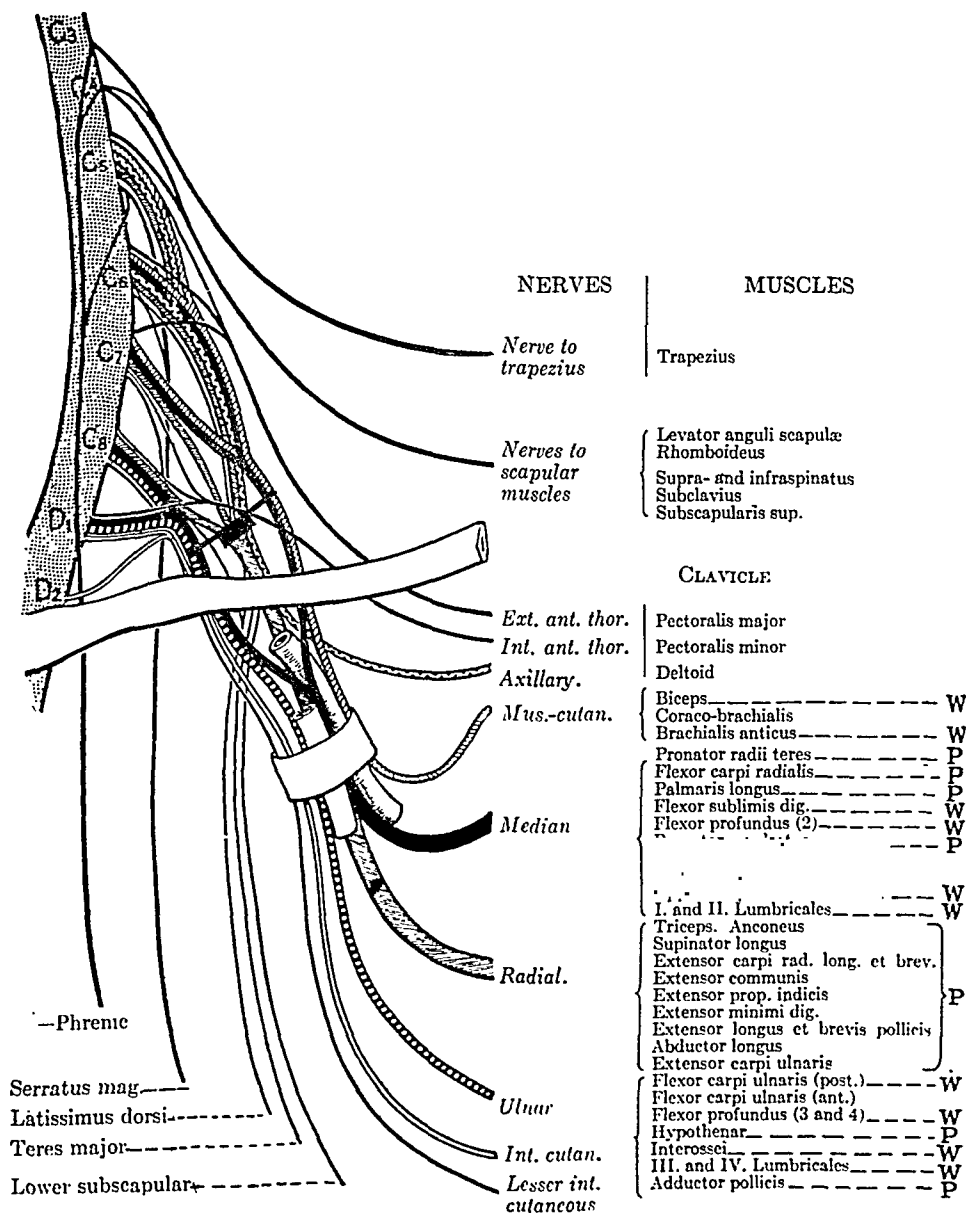


FIG. 239. Lesion of brachial plexus described in text. w, weak, p, paralyzed.

in which the supinators, extensors of the wrist, fingers and thumb and all of the muscles supplied by the ulnar and median

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nerves, excepting the pronators and flexor carpi radialis, were paralyzed. The last two muscles and the deltoid, biceps and triceps were weak.

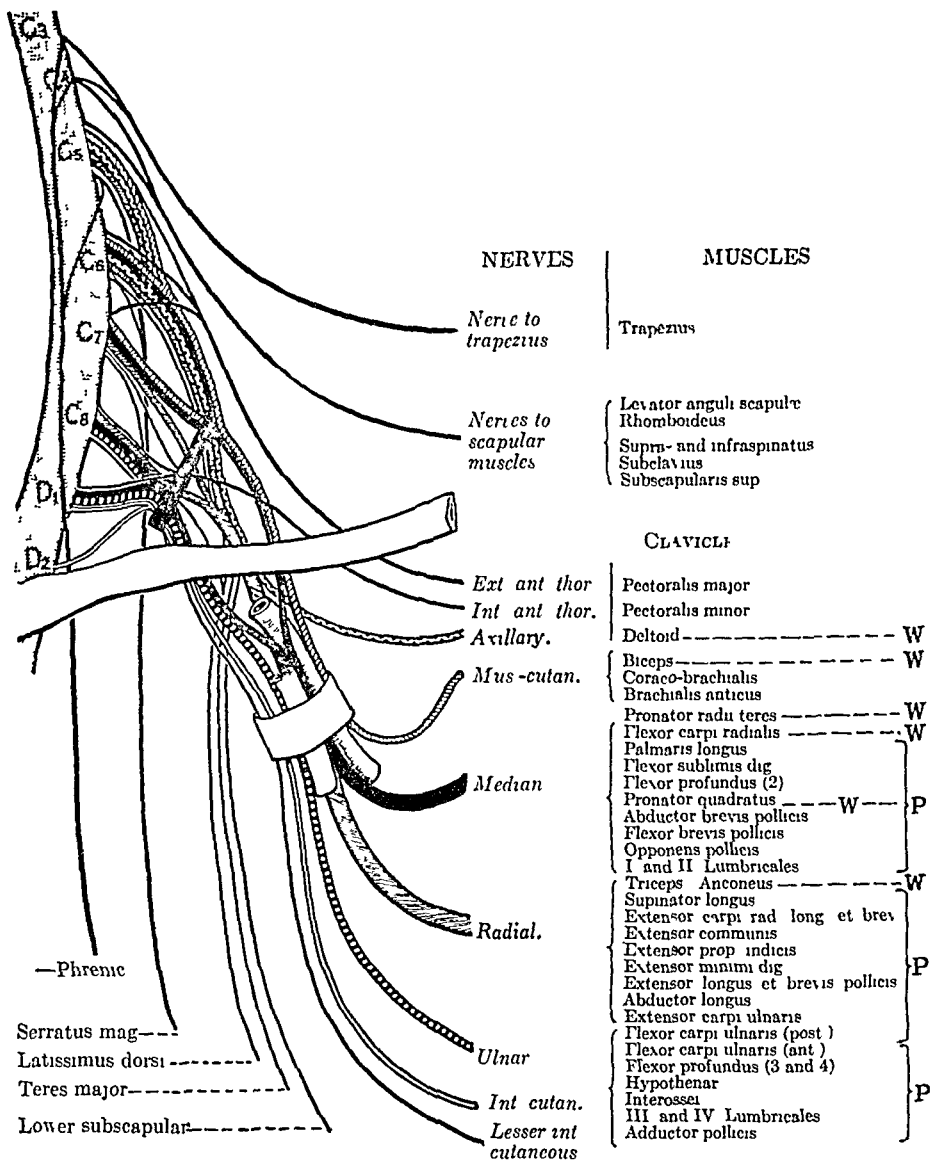


FIG. 240. Lesion of brachial plexus described in text. w, weak. p, paralyzed.

No case of isolated injury to the eighth cervical or first dorsal roots was observed, nor were any cases of pure inner

cord injuries seen. When the lower brachial plexus was found injured, part of the middle plexus was also included in the lesion. Axillary wounds produced a lesion which commonly

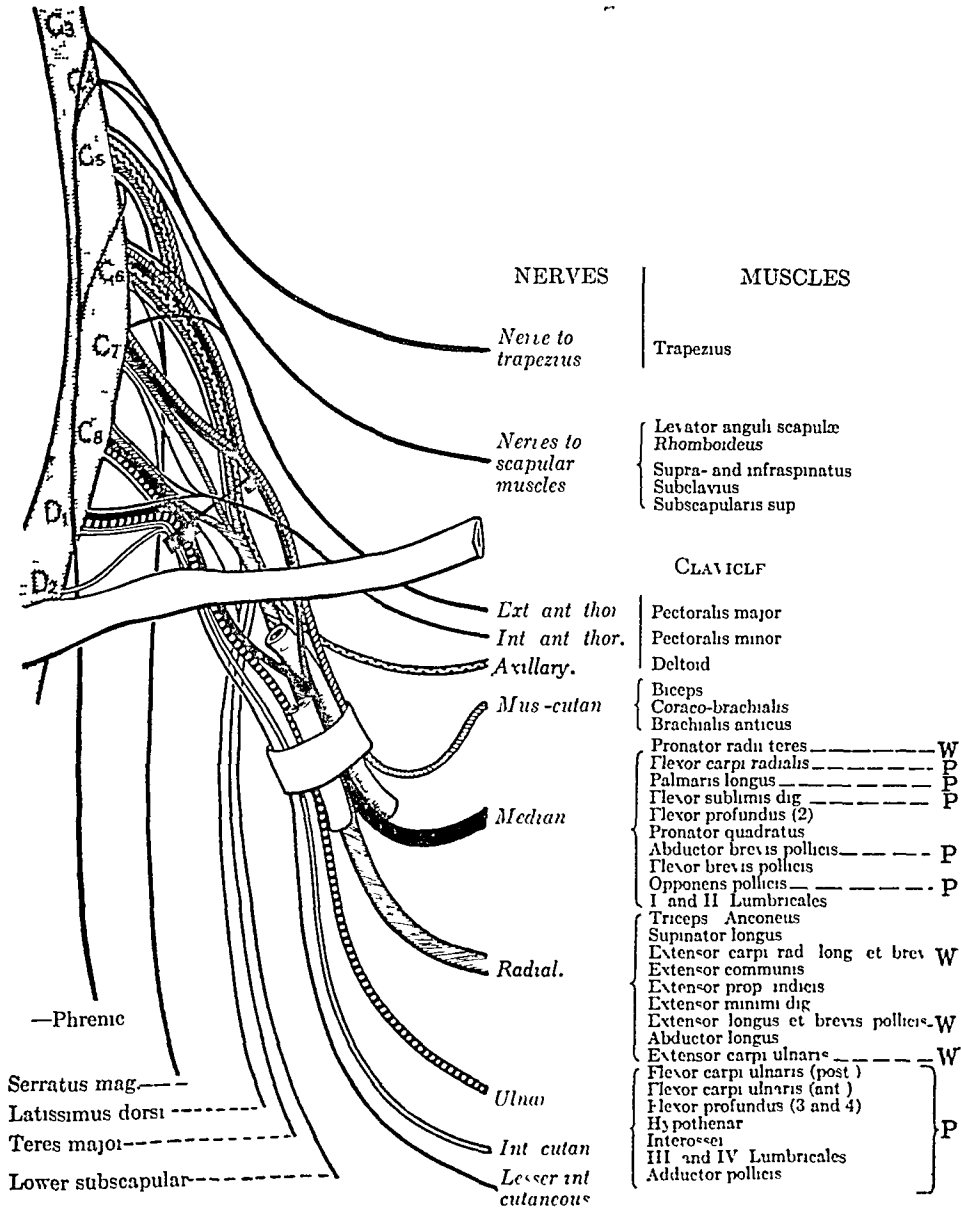


FIG. 241. Lesion of brachial plexus described in text. w, weak. p, paralyzed.

involved the ulnar and median nerves; at times, in addition, the radial or the musculocutaneous, and rarely all of the peripheral nerves of the brachial plexus. The medial cutaneous

THE BRACHIAL PLEXUS

nerves of the arm and forearm rarely escaped. At times the injury occurred before the complete formation of the median nerve.

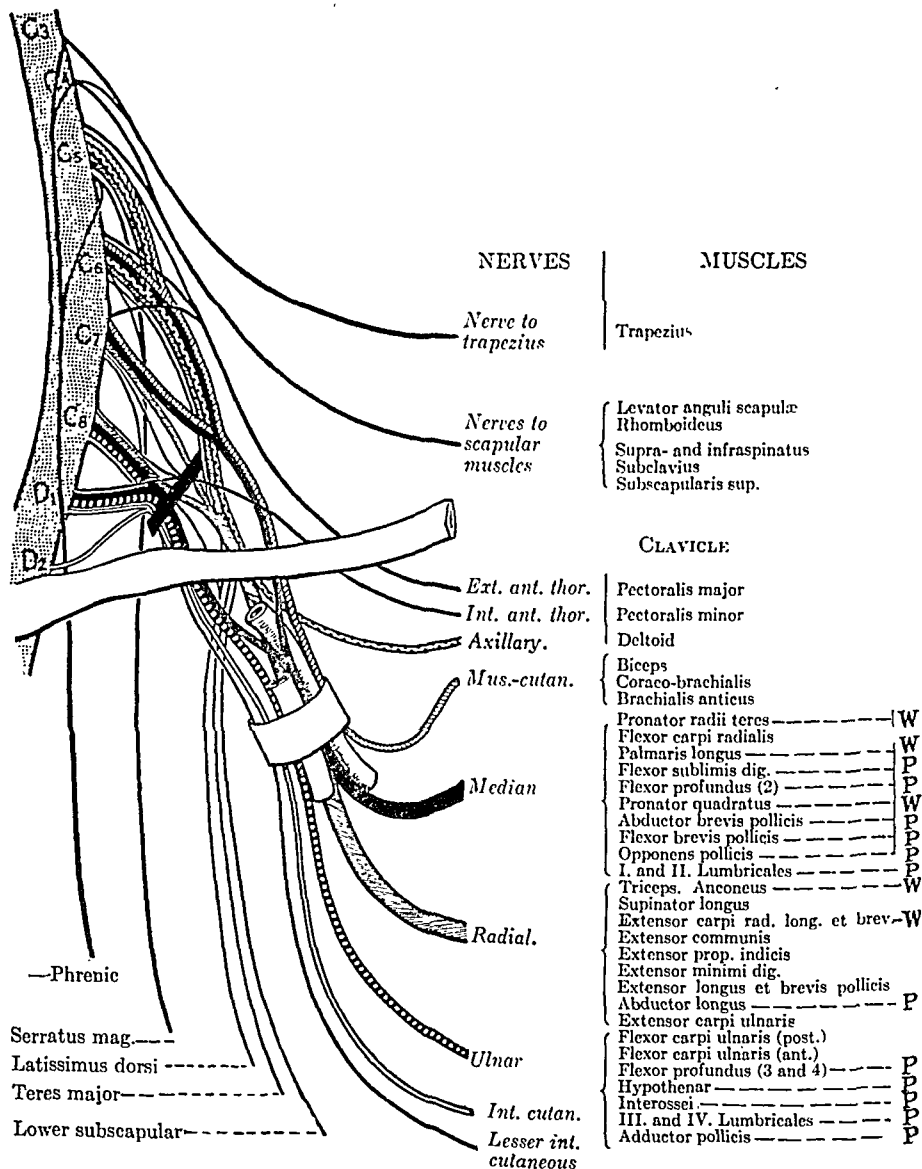


FIG. 242. Lesion of brachial plexus described in text. w, weak. p, paralyzed.

In Figure 241 is illustrated an injury of the inner cord and middle plexus which produced a paralysis of all of the muscles

supplied by the ulnar nerve, the opponens pollicis, the short abductor of the thumb, the flexor longus pollicis, the palmaris longus, the flexor sublimis digitorum and the flexor carpi

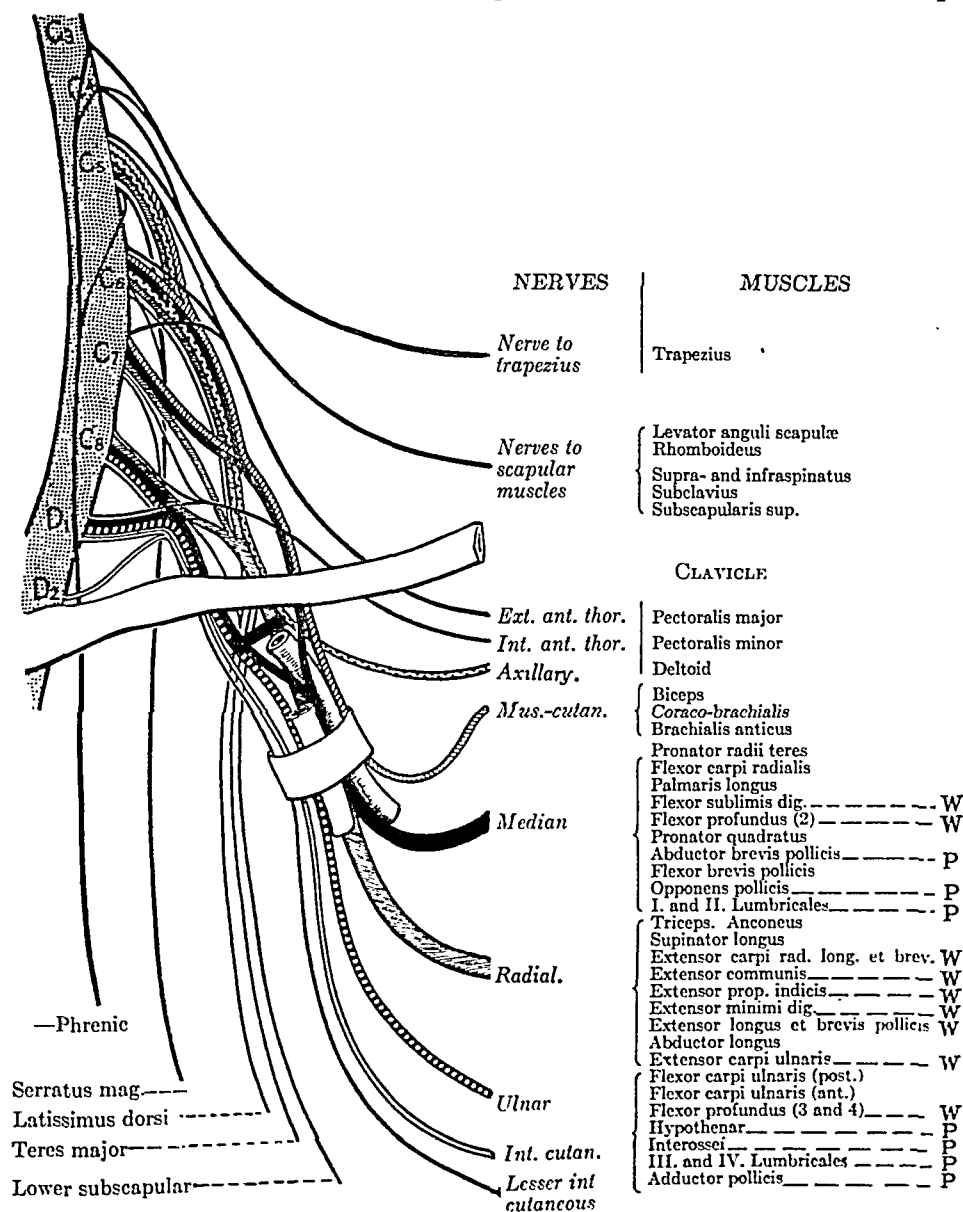


FIG. 243. Lesion of brachial plexus described in text. w, weak. p, paralyzed.

radialis. There was weakness of the pronators and of the extensors of the wrist and of the thumb.

In the case illustrated by Figure 242 there was a paralysis of all of the small hand muscles, the extensors of the fingers and thumb, the flexor longus and brevis pollicis, the flexors of

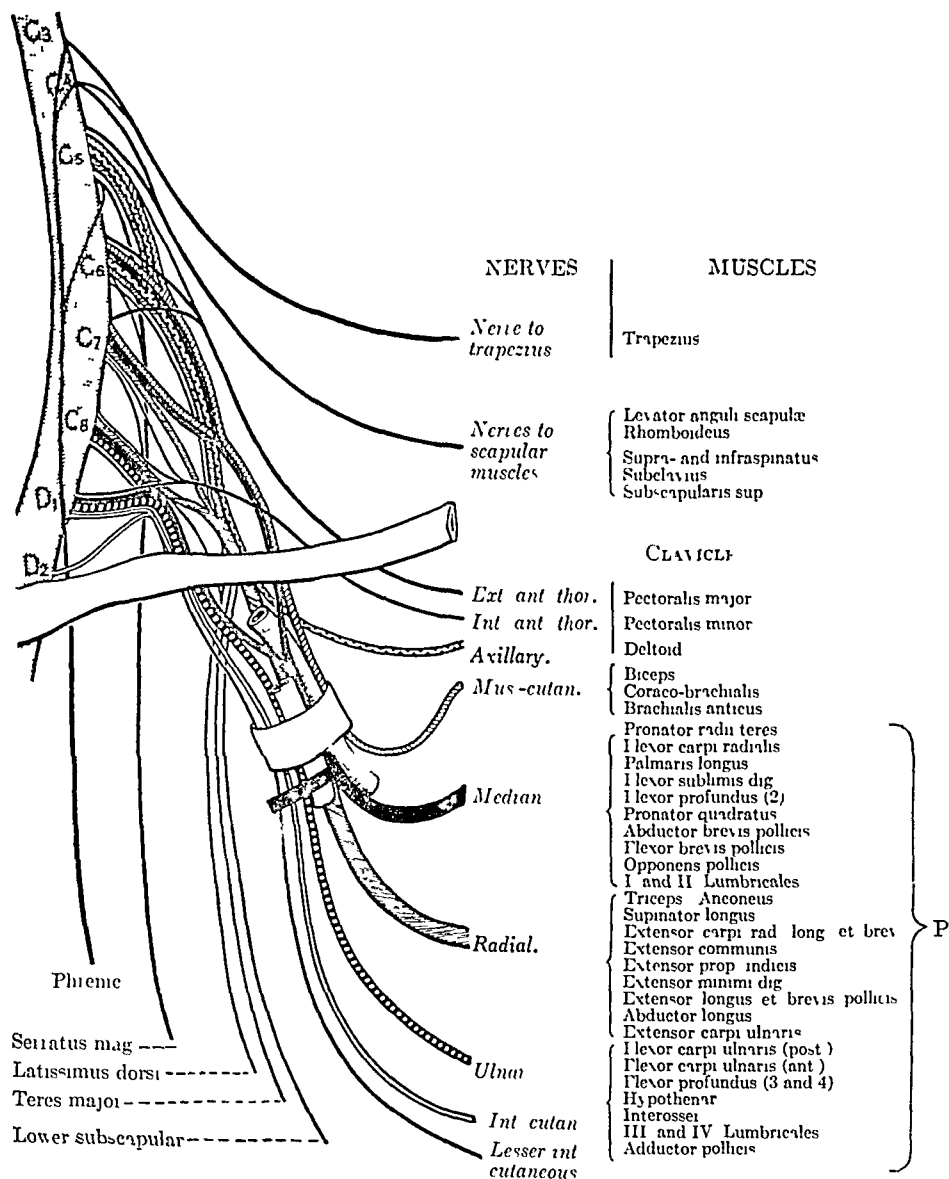


FIG. 244. Lesion of brachial plexus described in text. P, paralyzed.

the fingers, and a weakness in the triceps, extensors of the wrist, the pronators and palmaris longus. The sensory loss

occurred in the distribution of the eighth cervical and first dorsal segments only.

The outer head of the median nerve rarely escaped some

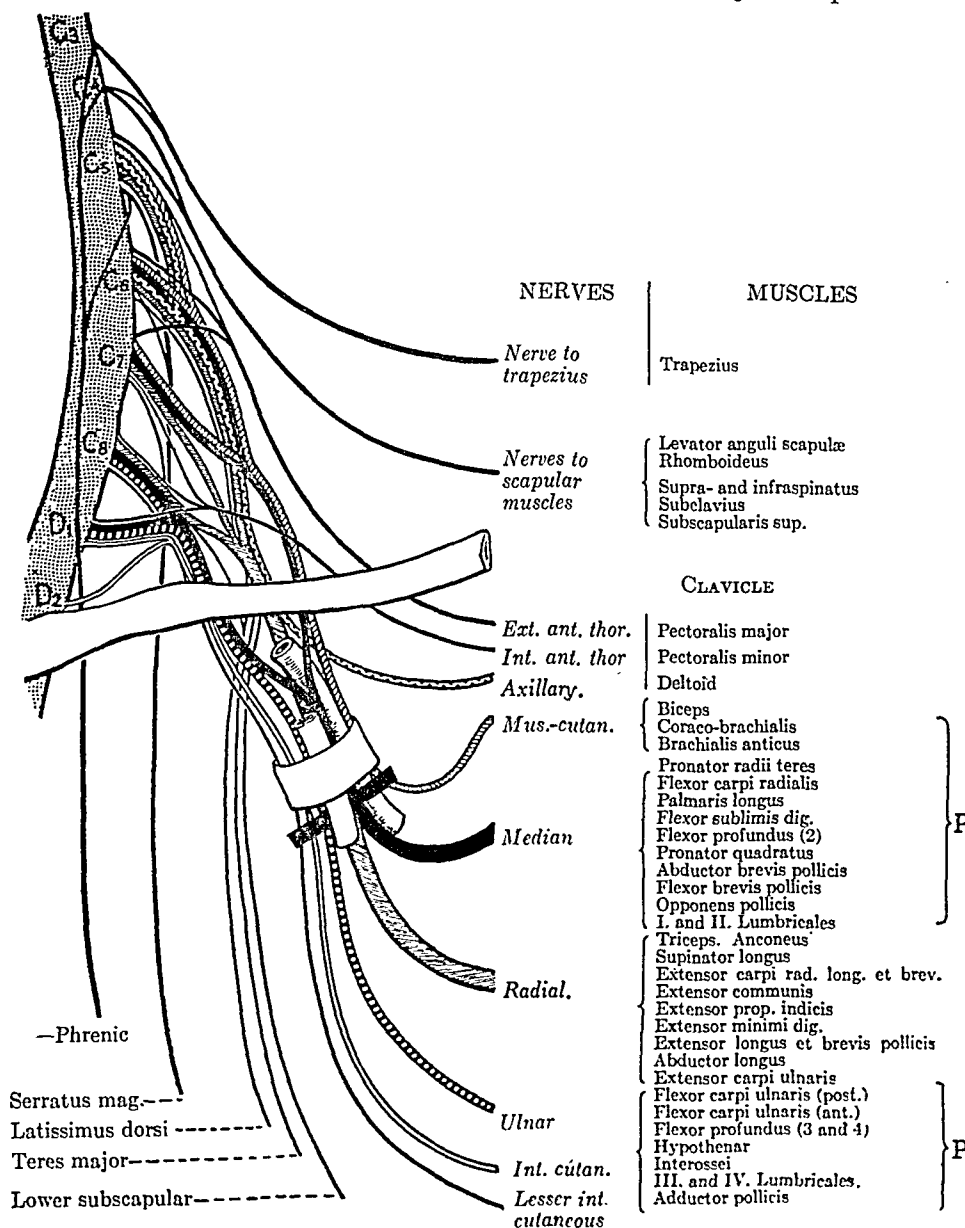


FIG. 245. Lesion of brachial plexus described in text. P, paralyzed.

injury in these lesions, although usually complete paralysis did not result. Occasionally it was entirely spared, as in the follow-

ing case (Fig. 243) in which a paralysis was seen in the small hand muscles, and the extensor longus pollicis. Slight weakness was present in the flexors of the fingers and marked weakness in

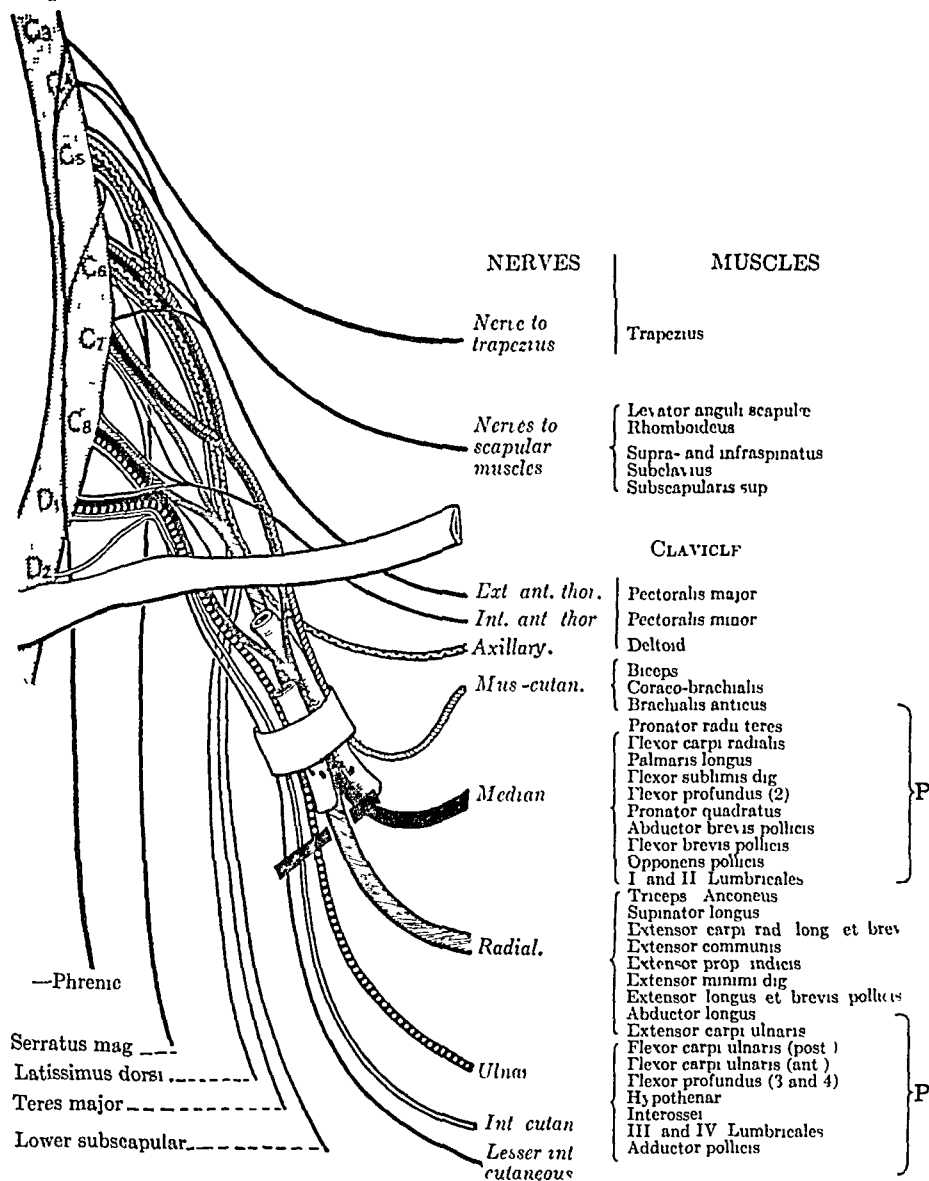


FIG. 246. Lesion of brachial plexus described in text. P, paralyzed.

the extensors of the fingers and wrist. The pronators and palmaris longus were spared. There was complete analgesia over the ulnar but none over the median distribution.

Axillary wounds produced lesions which corresponded in behavior to peripheral nerve injuries. The several nerves were injured in many combinations. Usually the ulnar, median and medial cutaneous nerves to the arm and forearm were injured together. At times the radial and rarely the musculocutaneous were likewise involved.

Figure 244 illustrates a case with paralysis of all of the muscles supplied by the ulnar, median and radial nerves. There was sensory loss over the medial cutaneous nerves of the arm and forearm.

Figure 245 illustrates a case in which the ulnar, median and musculocutaneous nerves were severed, and sensory loss was present over the medial cutaneous nerves of the arm and forearm.

Figure 246 represents a case in which the ulnar and median nerves were severed and sensory loss occurred over the distribution of the medial cutaneous nerves of the arm and forearm.

A few interesting observations may be made from the study of motor disturbances. Intravertebral root lesions occurred only when evidence of spinal cord injury existed. Paralysis of the latissimus dorsi and pectoral muscles occurred more frequently when the primary cords were injured. The supinators frequently escaped in a lesion which corresponded to the fifth cervical root. Lesions of completely formed nerves and of roots produced complete paralysis, whereas other lesions produced incomplete paralysis. In middle plexus lesions when the median nerve was slightly injured the opponens pollicis seemed to be the most vulnerable muscle.

A narrowed palpebral fissure, small pupil and enophthalmos, which were a part of the symptom-complex of the brachial plexus lesion described by Mme. Klumpke-Dejerine result primarily from injury to the eighth cervical or first and second dorsal roots. They are seen far more commonly in the brachial plexus injuries due to birth injury. When these symptoms are due to an injury of the cervical sympathetic chain, vasomotor disturbances and facial anhidrosis occur as well. This constitutes a Horner's syndrome.

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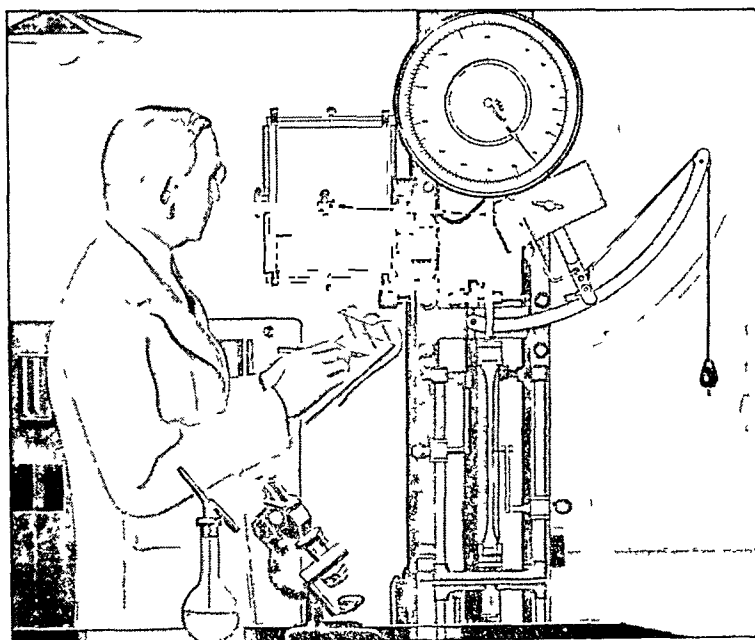
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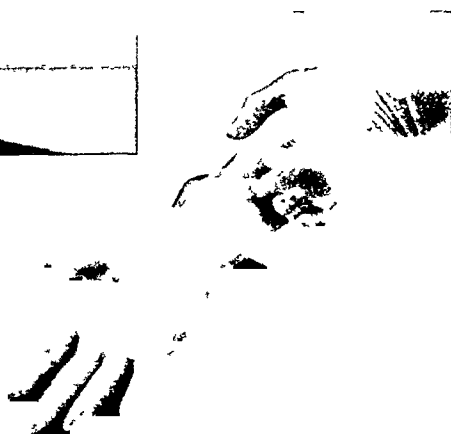


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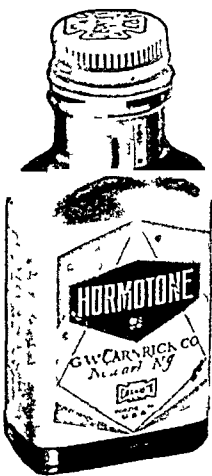
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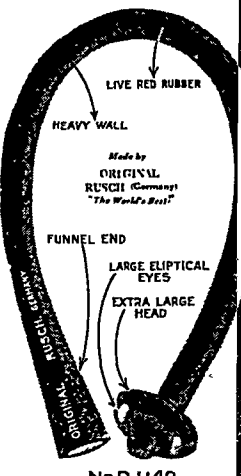
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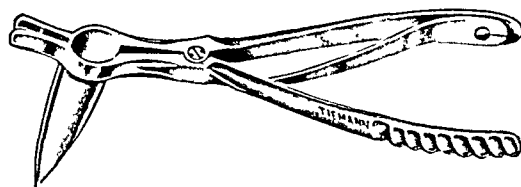
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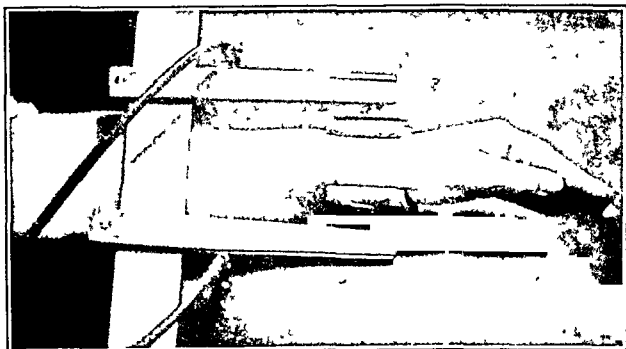
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